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Economic Impact Analysis of Effluent Standards and Limitations for the Metal Finishing Industry

Booz-Allen and Hamilton, Inc., Bethesda, MD

Prepared for

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The U.S. Environmental Protection Agency issued e-fluent guidelines and limitations for the Metal Finishing Industry in June 1983. This report estimates the economic impact of pollution control costs in terms of price changes, effects profitability, potentital plant closures, unemployment, and other secondary effects. A model plant approach is used to assess these impacts.

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EPA

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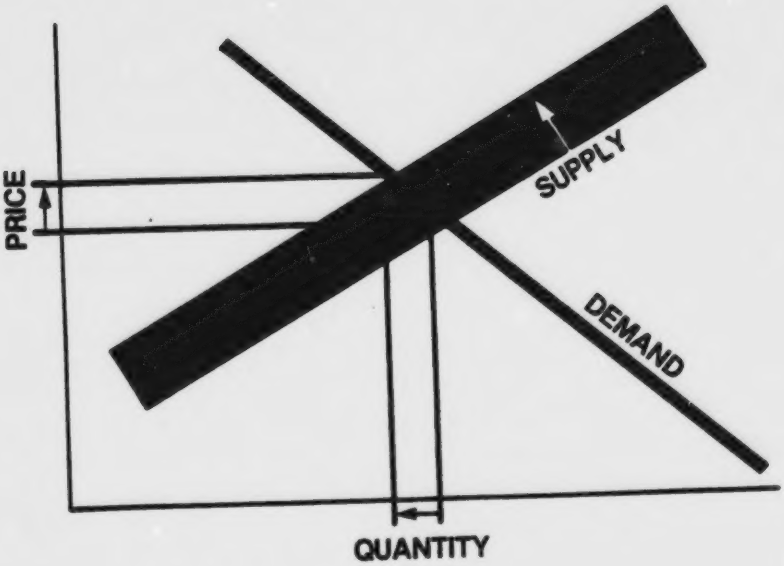

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***********ERRATA SHEET***********

Two lines were omitted at the bottom of page VI-3. The last sentence should read: The sections that follow describe the detailed impacts of each segment of the metal finishing universe.

This document is an economic impact assessment of the recently-issued effluent guidelines. The report is being distributed to EPA Regional Offices and state pollution control agencies and directed to the staff responsible for writing industrial discharge permits. The report includes detailed information on the costs and economic impacts of various treatment technologies. It should be helpful to the permit writer in evaluating the economic impacts on an industrial facility that must comply with BAT limitations or water quality standards.

The report is also being distributed to EPA Regional LIbraries, and copies are available from the National Technical Information Service (NTIS), 5282 Port Royal Road, Springfield, Virginia 22161 (703)487-4650.

If you have any questions about this report, or if you would like additional information on the economic impact of the regulation, please contact the Economic Analysis Staff in the Office of Water Regulations and Standards at EPA Headquarters:

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ECONOMIC IMPACT ANALYSIS OF EFFLUENT LIMITATIONS AND STANDARDS FOR THE METAL FINISHING INDUSTRY

U.S. Environmental Protection Agency
Office of Analysis and Evaluation
Washington, D.C. 20460

June 1983

EPA 440/2 83-007

PREFACE

This document is a contractor's study prepared for the Office of Water Regulations and Standards of the Environmental Protection Agency (EPA). The purpose of the study is to analyze the economic impact which could result from the application of effluent standards and limitations issued under Section 301, 304, 306 and 307 of the Clean Water Act to the metal finishing industry.

The study supplements the technical study (EPA Development Document) supporting the issuance of these regulations. The Development Document surveys existing and potential waste treatment control methods and technology within particular industrial source categories and supports certain standards and limitations based upon a analysis of the feasibility of these standards in accordance with the requirements of the Clean Water Act. Presented in the Development Document are the investment and operating costs associated with various control and treatment technologies. The attached document supplements this analysis by estimating the broader economic effects which might result from the application of various control methods and technologies. This study investigates the effect in terms of production cost increases, plant closures and divestitures, employment losses, and effects on investment.

The study has been prepared with the supervision and review of the Office of Water Regulations and Standards of EPA. The work was performed under contract no. 68-01-6214 by Booz, Allen & Hamilton Inc. The report was completed in June 1983.

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I. EXECUTIVE SUMMARY

I. EXECUTIVE SUMMARY

1. INTRODUCTION

This report presents the economic impacts of BPT/BAT and PSES/PSNS Water Pollution limitations and standards on the Metal Finishing Industry, and of amended PSES standards for job shop electroplaters. This study was prepared under the supervision of the Office of Analysis and Evaluation, U.S. Environmental Protection Agency. As required by the Clean Water Act, this study presents for consideration the economic impacts of the regulations which would control the industry's discharge of its effluents. Specifically this report includes:

- The economic characteristics and size of the Metal Finishing Industry
- Derivation of compliance costs
- Economic impact methodology
- Economic impacts on the Metal Finishing Industry due to the additional costs of meeting the regulations
- Analysis of new sources
- Regulatory Flexibility Analysis
- Methodology and cost appendices.

This Executive Summary presents a brief discussion of the following:

- Industry structure and characteristics
- Derivation of compliance costs
- Economic impact methodology
- Economic impacts
- Limits of the analysis.

The study is based on data from various sources, including a 1976-77 Survey of the Metal Finishing Industry, Dun and Bradstreet's Market Identifiers File, the Permit Compliance System (PCS) File, the 1977 Census of Manufacturers, the technical contractor for these regulations, and the Environmental Protection Agency files.

2. INDUSTRY STRUCTURE AND CHARACTERISTICS

For purposes of the economic analysis, the Metal Finishing Industry is divided into three segments: job shops, captives, and independent printed circuit board (IPCBs) manufacturers. The job shops are mostly small, privately-owned operations classified as SIC's 3471 and 3479 by the Standard Industrial Classification Manual. 3099 of the estimated 5500 job shops in those SIC's are forecasted to be affected by the BAT/amended PSES regulations: 365 direct dischargers and 2734 indirect dischargers. The remainder of the job shops do not perform regulated operations. The 3099 job shop plants accounted for $3.6 billion in sales in 1982 and employed 65,000 people. The job shop segment is competitive, with a 4-firm concentration ratio of 7.2 percent in SIC 3471 and 15.1 percent in SIC 3479.

The captive segment of the Metal Finishing Industry is comprised of plants or production centers found within manufacturing firms which provide metal finishing services to the parent company. There are an estimated 10,000 captive plants that will be covered by these effluent guidelines, 7500 indirect dischargers and 2500 direct dischargers. Captive metal finishing operations occur in an estimated 150 four digit SIC's and vary in size from $1 million to over $100 million in sales in 1982 dollars.* Further, captive plants vary with respect to the relative importance of their metal finishing operations and the degree with which they provide finishing services to outside customers. Plants range from those which metal finish all of their own goods to those which occasionally finish in-house goods, and take in finishing work from other producers. The total value of shipments of the captives is estimated at $140 billion, shipments of just the metal finished goods is on the order of $76 billion, and total employment in captive plants is 6.5 million. Metal finishing process employment is estimated at 0.6 million. The independent printed circuit board manufacturing segment population is estimated at 371 plants. A total of

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* Information based on the 1976 survey of metal finishers. All dollar amounts in this report were updated to 1982 dollars using the implicit price deflator, durable goods sector, Survey of Current Business, published by the Bureau of Economic Analysis, U.S. Department of Commerce.

327 IPCBs are indirect dischargers and 44 are direct dischargers. The IPCB segment employs about 24,200 people and accounted for an estimated $1.3 billion in sales in 1982.* [Exhibit I-1 on the following page contains summary data on the industry.]

3. REGULATORY OPTIONS

The economic analysis evaluated two regulatory options for existing industrial sources. A third option was also evaluated for new sources. Each option sets a compliance standard based on identified pollution control technologies. This economic analysis assesses the impact of installing these identified control technologies. The following pollution abatement equipment, where applicable, is assessed for each option:

- Option I control includes:
    - Precipitation/clarification
    - Hexavalent chrome reduction
    - Alkaline chlorination
    - Sludge dewatering
    - No dumping of total toxic organics (TTO).
- Option II equipment includes all of the equipment necessary to meet Option I with the addition of a Multimedia Filtration Unit.
- Option III equipment includes all of the equipment necessary to meet Option I plus in-plant controls on cadmium.

4. DERIVATION OF COMPLIANCE COSTS

The derivation of water pollution control costs differs somewhat between job shops and captives.

(1) Job Shop Plant Costing

Information from the 1976-77 Survey of Metal Plants Finishers on 244 job shop model plants in the data base was submitted to the technical contractor for costing. Each plant was run individually through the technical contractor's cost generating program. The key parameters considered were:

- Flow constituents
- Plant layout

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* Information based on the 1976 survey of independent printed circuit board manufacturers.

EXHIBIT I-1

Characteristics of the Regulated Metal Finishing Universe

	Job Shops			IPCB			Captives		
	I. Disch.	D. Disch.	Total	I. Disch.	D. Disch.	Total	I. Disch.	D. Disch.	Total
Number of Plants	2,734	365	3,099	327	44	371	7,500	2,500	10,000
Value of Shipments (Billions 1982 $)	2.70	0.40	3.1	1.1	0.2	1.3	106.0	34.8	141.1
Total Employment (000)	58.4	8.8	67.2	21.3	2.9	24.2	4,900	1,640	6,540
Employment in Metalfinishing Process (000)	58.4	8.8	67.2	11.5	1.6	13.1	450	150	600

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- Materials finished
- Hours of operations
- Finishing processes
- Amperage, thickness of plate
- Equipment in place
- Tooling, piping
- Construction, laboratory costs.

Except for the control of total toxic organics, all direct discharging job shops are in compliance with Option I requirements. Therefore, direct discharging job shops were costed only for compliance with the TTO limit and the marginal cost of achieving Option II compliance requirements from Option I requirements. An estimated 15.5 percent or 56 of the direct discharging facilities are projected to baseline monitor for TTO and 2.8 percent or 10 facilities are projected to compliance monitor for TTO. Baseline monitoring costs are $1,904 per facility while annual compliance costs are $2,890 per facility. All 365 direct discharging job shops were costed for a multimedia filtration unit under Option II.

Indirect discharging job shops are subject only to existing PSES, plus the amended TTO limitations. The TTO amendment will impose no capital costs. Thus they were costed only for baseline and compliance monitoring for the TTO limit. An estimated 15.5 percent (or 424) of these facilities will have to compliance monitor on a one time basis and 2.8 percent (or 77) were projected to compliance monitor annually.

(2) IPCB Plant Costing

The independent printed circuit board manufacturers all already meet direct discharge limits or are subject to PSES electroplating standards. This rulemaking adds only TTO control to their obligations. It will involve no capital cost. Thus they were costed only for monitoring TTO. The Agency assumed that all 371 IPCBs will have to baseline monitor at a per-plant cost of $1,904, and 27 percent (or 100) will be required to compliance monitor with per-plant costs of $2,890 annually.

(3) Captive Plant Costing

Information on processes of captive plants was not available from the 1976-77 survey of metal finishers. As a result, the technical contractor developed cost estimates on its own sample of 100 indirect discharging captive model plants and 100 direct discharging captive model plants. Each plant in the sample was costed by the technical contractor's costing program for both Option I and Option II compliance requirements. This costing assumes treatment of all wastewater flows, even those generated from non-metal finishing processes. Therefore, cost estimates may be overstated.

The technical contractor also developed costs for the electroplating flow of each indirect discharging* model plant in its sample. This was done to isolate the electroplating portion of the metalfinishing flow which was costed in an earlier electroplating pretreatment regulation.

The technical contractor's model plants were then linked to the economic data base on the basis of water flow -- the common variable. Total plant flow was not functionally related to previously regulated flows. Thus a strong functional relationship could not be established on a plant-by-plant basis between the technical contractor's plant total water flow and estimated metal finishing investment costs. Instead, the model plants were grouped into water usage categories (separate for each discharging mode) with their corresponding costs. These groupings established a relationship between water usage and costs so that the model plants in the economic data base could be costed. These cost groupings are displayed in Appendix B.

Both baseline monitoring and compliance monitoring estimates for total toxic organics were developed by the Environmental Protection Agency. These costs are for monitoring. Thus they are the same for all plants that are required to comply regardless of size. A detailed discussion of these costs is presented in Chapter V.

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* Amongst the indirect dischargers, EPA drew a distinction between "integrated" and "non-integrated" plants. Integrated plants are those whose metal finishing processes include both electroplating and non-electroplating processes. Non-integrated plants have only electroplating processes. The 1979 Electroplating Pretreatment Standards regulate all electroplating processes in metal finishing plants.

5. NEW SOURCE PERFORMANCE STANDARDS/PRETREATMENT STANDARDS FOR NEW SOURCES

New Source Performance Standards/Pretreatment Standards for New Sources were estimated for new source metal finishers that will need in-plant cadmium controls. The cadmium controls will result in an additional annual compliance cost of between $14,388 and $24,436 (in 1982 dollars) per plant. These costs are not expected to have adverse competitive impacts. A more detailed analysis is presented in Chapter IX.

6. ECONOMIC IMPACT METHODOLOGY

As in costing, a different analysis was developed for each industry segment. Each method is presented below.

(1) JOB SHOPS

The economic impact analysis for the job shops consisted of a financial assessment of 244 model plants and their capacity to handle the incremental cost of the capital investment. This methodology is the same as that used in developing the 1979 pretreatment standards for existing source electroplaters.

Estimated costs and a linked price increase that passes through these costs to customers are used to calculate new financial statements for each model plant. These statements forecast what the firm's financial performance would be in the first year after an investment. A closure is a plant that would close either because of inadequate cash flow to support a bank loan to purchase the equipment or from inadequate profits to the owners. Plants with a coverage ratio (which is the projected cash flow divided by scheduled loan repayments) of less than 1.5 are deemed closures in this analysis.

(2) INDEPENDENT PRINTED CIRCUIT BOARDS

The methodology for assessing the economic impacts on the IPCB sector is identical to the methodology used in the job shop analysis, with one exception. The financial statements for the 100 IPCB model plants did not contain information on owners' compensation. Consequently, the equity infusion test conducted for job shops could not be performed for IPCBs. This deletion increases the likelihood that this model would predict closures.

(3) CAPTIVE ANALYSIS

The analysis of the economic effects on captives of the investment in pollution control equipment is based upon considerations of both changes in plant costs and industry-wide changes in cost. Firms which will experience much higher relative cost increases than the industry average will not be able to raise prices sufficiently to fully recover their added cost. The closure routine identifies captive firms which are candidates to close or divest their metal finishing operations because they are unable to change prices sufficiently to fully recover the costs of pollution control. The flow chart on the next page illustrates the closure logic for the captive sector.

7. ECONOMIC IMPACTS

The estimated economic impacts of the regulations are different for Option I compliance levels and Option II compliance levels. In both cases, the costs of complying with the 1979 Electroplating Pretreatment Standards were factored into the baseline conditions.

Exhibit I-3 shows that the total annual compliance burden of Option I is $118.0 million. Only indirect discharging captives will have to make capital investments to comply with this regulation. Surveys* conducted by the Agency show that all direct dischargers and 72 percent of indirect discharging captives have the necessary equipment in place to meet.compliance with Option I control levels. One reason for the high rate of equipment in place is that indirect dischargers are subject to earlier pretreatment regulations. Also, direct dischargers have to comply with NPDES permit limitations. All segments of the universe may have to monitor for total toxic organics.

Exhibits I-3 and I-4 display the costs and impacts of the regulation. The sections below describe the impacts on each segment of the metal finishing universe.

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* The results of the first survey are outlined in a July 30, 1981 memorandum from Mr. Richard Kinch to Mr. Art Berman. The second survey's sample design and selection procedure is described in an August 20, 1981 memorandum from Mr. Richard Kotz to Mr. David Pepson. The results of the survey are contained in a memorandum from Mr. Henry D. Kahn to Mr. David Pepson. The results of the last survey are described in a memorandum dated December 3, 1981 from Mr. Kinch to Mr. Berman.

EXHIBIT I-2

FLOWCHART OF THE CAPTIVE PLANTS CLOSURE ROUTINE

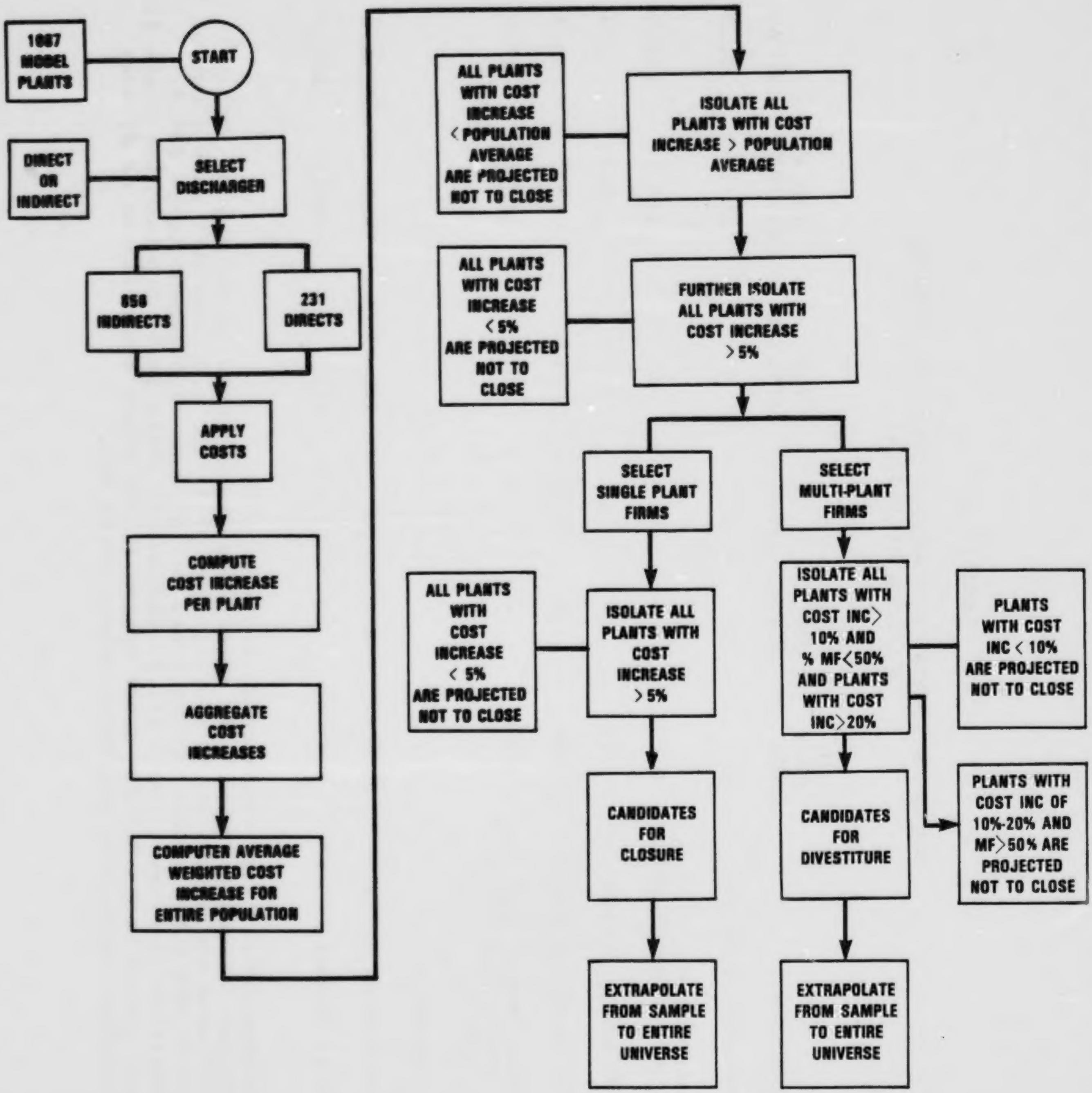
1087 MODEL PLANTS
START
DIRECT OR INDIRECT
SELECT DISCHARGER
856 INDIRECTS
231 DIRECTS
APPLY COSTS
COMPUTE COST INCREASE PER PLANT
AGGREGATE COST INCREASES
COMPUTER AVERAGE WEIGHTED COST INCREASE FOR ENTIRE POPULATION
ALL PLANTS WITH COST INCREASE < POPULATION AVERAGE ARE PROJECTED NOT TO CLOSE
ISOLATE ALL PLANTS WITH COST INCREASE > POPULATION AVERAGE
ALL PLANTS WITH COST INCREASE < 5% ARE PROJECTED NOT TO CLOSE
FURTHER ISOLATE ALL PLANTS WITH COST INCREASE > 5%
SELECT SINGLE PLANT FIRMS
SELECT MULTI-PLANT FIRMS
ALL PLANTS WITH COST INCREASE < 5% ARE PROJECTED NOT TO CLOSE
ISOLATE ALL PLANTS WITH COST INCREASE > 5%
ISOLATE ALL PLANTS WITH COST INC> 10% AND % MF<50% AND PLANTS WITH COST INC>20%
PLANTS WITH COST INC < 10% ARE PROJECTED NOT TO CLOSE
PLANTS WITH COST INC OF 10%-20% AND MF>50% ARE PROJECTED NOT TO CLOSE
CANDIDATES FOR CLOSURE
CANDIDATES FOR DIVESTITURE
EXTRAPOLATE FROM SAMPLE TO ENTIRE UNIVERSE
EXTRAPOLATE FROM SAMPLE TO ENTIRE UNIVERSE

EXHIBIT I-3

TOTAL INVESTMENT AND ANNUAL COSTS BY OPTIONS
(Million of 1982 $)

OPTION I	D.D. JOB SHOPS	I.D. JOB SHOPS	IPCB	D.D. CAPTIVES	I.D.** CAPTIVE	TOTAL
Investment Costs	0	0	0	0	351.0	351.0
Annualized Investment Costs	0	0	0	0	115.6	115.6
TTO Annual Costs	.02	.2	.3	.5	1.4	2.4
TTO Baseline Costs	.08	.8	.8	1.7	5.1	10.4
Total Annual Costs (Including TTO costs)	.02	.2	.3	.5	116.6	118.0
OPTION II						
Investment Costs	18.6	0	0	442	1050	1510.6
Total Annual Costs*	6.1	.2	1.1	146	348.6	502.1

* Includes total toxic organics monitoring costs

** Includes I.D. Captives with MF water flow of less than 10,000 G.P.D. Total investment and annual costs (in millions of $) for I.D. captives with flows of less than 10,000 G.P.D. under Option I are as follows: investment costs $35.9, annualized investment costs $11.8, TTO annual costs $0.5, TTO baseline costs $1.9, total annual costs $12.0. Under Option II the costs (in millions of $) are: investment costs $63, and total annual costs $21.

EXHIBIT I-4

ESTIMATED IMPACTS OF REGULATORY COMPLIANCE

OPTION I	D.D. JOB SHOPS	I.D. JOB SHOPS	IPCB	D.D. CAPTIVES	I.D.* CAPTIVE
Plant Closures	0	0	0	0	0
MF Divestitures	0	0	0	0	0
Employment Loss	0	0	0	0	0
% Average Cost Increase	0.02	0.02	0.03	0.01	0.2
OPTION II					
Plant Closures	50	0	0	21	8
MF Divestitures	0	0	0	10	0
Employment Loss	1,365	0	0	760	185
% Average Cost Increase	4	0.1	0.1	0.5	0.6

* Includes I.D. Captives with MF flow of less then 10,000 G.P.D. Regulatory compliance of I.D. captives with flow of less than 10,000 G.P.D. under both Options I and II will result in no plant closures, MF divestitures or employment losses. The average cost increase under both options is 1 percent.

(1) Direct Discharging Job Shops

No establishments in this segment will be required to make capital investments in order to meet Option I compliance level. An estimated 10 direct discharging job shops may have to compliance monitor for total toxic organics at an estimated annual cost of $29,000 ($2,890 per facility) and an estimated 56 facilities may have to one-time baseline monitor at an estimated $108,000 ($1,904 per plant). No closures are forecasted for this segment. The cost of production are estimated to increase by 0.02 percent.

(2) Indirect Discharging Job Shops

This regulation does not alter the metals and cyanide limits for indirect discharging job shops. Thus they will not have to make capital investments to meet Option I compliance levels. This analysis assumes that a total of 424 shops will have to baseline monitor for TTO for a total one-time cost of $807,000, and 77 shops will have to monitor for compliance for a total cost of $220,000. The per-plant annual costs of $2,890 are expected to increase the cost of production* by 0.02 percent. No closures are expected in this segment.

Since the compliance date is set for the year 1986, it was assumed that job shops will elect to baseline monitor before that year and, thus, that the costs for the two monitoring functions will not occur in the same year. If the two monitoring functions had occurred in the same year, one job shop might have closed.

(3) Direct Discharging Independent Printed Circuit Board Manufacturers

This analysis assumes that this segment of the universe would monitor for total toxic organics. All 44 IPCBs may have to baseline monitor at a cost of $83,700 and 12 may have to monitor for compliance annually at an estimated total cost of $34,700. Production costs are estimated to increase by 0.03 percent. No IPCBs will close due to the requirements regardless of compliance dates.

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* Cost of production increase is computed as the ratio of annual compliance costs to revenues. This ratio represents the percentage increase in revenues required to cover the compliance costs.

(4) Indirect Discharging Independent Printed Circuit Board Manufacturers

This analysis assumes that all indirect discharging IPCBs will be required to monitor for total toxic organics. If all 327 will have to baseline monitor there will be a one-time cost of $623,000. A total of 88 indirect discharging IPCBs are established to compliance monitor at a total cost of approximately $254,000. Cost of production are estimated to increase by 0.03 percent. No IPCBs will close due to the requirements.

(5) Direct Discharging Captives

Except for compliance with the TTO limit, all direct discharging captives have the necessary equipment in place to meet Option I compliance requirements. A total of 900 direct captives may baseline monitor at an estimated one-time cost of $1.7 million. In addition, 162 of the 900 may have to compliance monitor at an annual total cost of $468,000. No plant closures are forecasted for this segment, and the estimated production cost increase is 0.01 percent.

(6) Indirect Discharging Captives

Total investment cost for this segment is estimated at $351.0 million, with annual costs of $116.6 million. Baseline monitoring for total toxic organics could affect 2,700 plants (including the 1,026 plants with less than 10,000 G.P.D.) resulting in a total cost of $5.1 million. Annual compliance monitoring may affect 487 indirect captives with an estimated total cost of $1.4 million. No closures or divestitures are forecasted for indirect discharging captives. Cost of production is estimated to increase by 0.2 percent.

1. Indirect Discharging Captives With Water Usage of Less Than 10,000 G.P.D.

This sub-segment of the affected universe is made up of 2,850 non-integrated indirect discharging captives. They may be required to invest in Option I equipment as well as monitor for total toxic organics. A total of 912 plants (32 percent of population) may have to make the investment in equipment. Total capital investment costs are estimated to be $35.9 million with annual costs of $11.8 million. The onetime baseline monitoring costs for total toxic organics could affect 1,026 plants with total costs of $1.9 million. Annual compliance monitoring costs for total toxic organics may total $500,000, affecting 185 plants. No plant closures are forecast for this segment. Cost of production will increase by about 1 percent.

Exhibits I-3 and I-4 summarize the estimated costs and impacts of complying with Option II. The investment costs for Option II are estimated at $1,510.6 million with annual costs of $502.1 million. A total of 50 direct discharging job shops would close, with an employment loss of 1,365 workers and a cost increase of four percent of total sales. Direct discharging captives would experience 21 plant closures and 10 divestitures, with an employment loss of 760 and a cost increase of 0.5 percent. Indirect discharging captives would experience 8 plant closures and employment loss of 185.

II. INTRODUCTION

II. INTRODUCTION

This chapter provides a brief overview of the content and direction of the report. It serves to highlight the rationale for the rule-making effort as well as the approach chosen for the industry analysis. To guide a review of the work the chapter deals with the following major issues:

- History of the metal finishing regulation
- Unique nature of the industry
- Organization of the economic impact analysis

1. THE REGULATION

The metal finishing industry has been affected by EPA pollution control regulations since 1972. The 1972 Clean Water Act (as amended) states:

- "By July 1, 1977, existing industrial dischargers were required to achieve effluent limitations requiring the application of the best practicable control technology currently available' ("BPT"), Section 301(b)(1)(A); and by July 1, 1983, these dischargers were required to achieve 'effluent limitations requiring the application of the best available technology economically achievable... which will result in reasonable further progress toward the national goal of eliminating the discharge of all pollutants' ("BAT"), Section 301(b)(2)(A).

- New industrial direct dischargers were required to comply with Section 306 new source performance standards ("NSPS"), based on best available demonstrated technology, and new and existing dischargers to publicly owned treatment works ("POTWs") were subject to pretreatment standards under Sections 307(b) and (c) of the Act. While the requirements for direct dischargers were to be incorporated into National Pollutant Discharge Elimination System (NPDES) permits issued under Section 402 of the Act, pretreatment standards were made enforceable directly against dischargers to POTWs (indirect dischargers)."

Pretreatment Standards for Existing Source Electroplaters were promulgated in September of 1979.

With the revisions of the 1977 Clean Water Act, Sections 301(b)(2)(a) and 301(b)(2)(C) of the Act now require the achievement by July 1, 1984 of effluent limitations requiring application of BAT for "toxic" pollutants, including the 65 "priority" pollutants and classes of pollutants which Congress declared "toxic" under Section 307(a) of the Act.

In this rulemaking, the Agency has defined the costs and pollution control technologies appropriate for effluent limitations for existing sources after July 1, 1977, ("Best Practicable Control Currently Available") and after July 1, 1984 ("Best Available Technology Economically Achievable"). Costs and levels of technology appropriate for pretreatment of wastewater discharges to POTW's from both new and existing sources were also identified.

2. THE INDUSTRY

For purposes of this regulation, the metal finishing industry consists of any manufacturing establishment performing one or more of the following process operations: electroplating, electroless plating, anodizing, casting, chemical etching and milling or printed circuit board manufacture. If these operations are present, this regulation applies to wastewater discharges from any of the 45 unit operations shown in Exhibit II-1 on the following page.

Two commercial segments are most likely to perform these operations. One is the small, job shop covered under SIC's (Standard Industrial Code Classification) 3471 and 3479. The other sector includes any establishment producing a final good in which metal finishing is an intermediary step in the production cycle. Such establishments are called "captives" and are primarily associated with SIC's 34 through 39. The two segments comprise the metal finishing industry. They are, however, structurally different, and different economic analyses are required for each:

- The job shop segment constitutes a definable market (SIC's 3471/3479). It produces a final product which is metal finishing services. The captive sector is not an industry; rather it represents plants within which a metal finishing process is performed.

EXHIBIT II-1

Metal Finishing Category Unit Operations

UNIT OPERATIONS

1. Electroplating
2. Electoless Plating
3. Anodizing
4. Conversion Coating
5. Etching (Chemical Milling)
6. Cleaning
7. Machining
8. Grinding
9. Polishing
10. Tumbling
11. Burnishing
12. Impact Deformation
13. Pressure Deformation
14. Shearing
15. Heat Treating
16. Thermal Cutting
17. Welding
18. Brazing
19. Soldering
20. Flame Spraying
21. Sand Blasting
22. Other Abrasive Jet Machining
23. Electric Discharge Machining
24. Electrochemical Machining
25. Electron Beam Machining
26. Laser Beam Machining
27. Plasma Arc Machining
28. Ultrasonic Machining
29. Sintering
30. Laminating
31. Hot Dip Coating
32. Sputtering
33. Vapor Plating
34. Thermal Infusion
35. Salt Bath Descaling
36. Sovlent Degreasing
37. Paint Stripping
38. Painting
39. Electrostatic Painting
40. Electroplating
41. Vacuum Metalizing
42. Assembly
43. Calibration
44. Testing
45. Mechanical Plating

- A job shop faces a demand curve for its services while the demand curve facing captive metal finishers is for a final product, one of whose production inputs is a metal finishing service. That is, the demand for metal finishing in captive operations is a derived demand for production inputs, rather than a primary demand for a specific good or service.

- The prices for job shop services are determined by the market. However, there are no market prices for captive metal finishers. The "prices" of metal finishing services performed by captives are determined by accounting procedures and are used for internal transfers alone.

Given the fundamental differences between the two sectors, two separate designs and methods were developed for the industry impact analysis.

3. ORGANIZATION

This report consists of nine chapters and six appendices. The third through the sixth chapters represent the major substantive sections. In the third chapter the characteristics of the metal finishing universe are presented. Chapter five presents the costs developed by the Agency's technical contractor, coupled with the guidance from the Agency on such matters as the affected segment of the universe, degree of equipment in place and stringency of the regulatory scenarios. Chapters four and six are tightly linked with designing the methods for calculating impacts and displaying the estimates of resulting impacts on the industry. Subsequent chapters reflect the added considerations of the regulatory review including:

- Regulatory Flexibility

- The effect of New Source Performance Standards and of Pretreatment Standards for New Sources on future entry to the industry.

The report closes with a discussion of the possible limitations on the reliability or validity of the analysis.

* * * * *

III. CHARACTERISTICS OF THE METAL FINISHING UNIVERSE

III. CHARACTERISTICS OF THE METAL FINISHING UNIVERSE

1. INTRODUCTION

This description of the economic and financial characteristics of the metal finishing universe is organized on the basis of the three industry sectors, job shops, IPCBs and captives. Job shops, IPCBs, and captives are engaged in similar production activities, but face different economic variables. The job shop sector constitutes a definable industry and provides finishing services as a final product to outside customers. Job shops fall into the standard industrial classifications (SIC) of 3471 and 3479. The captive sector does not constitute an industry in the normal sense. Captives perform metal finishing operations as part of the production process and for the most part do not provide finishing services to outside customers as a final good. Further, captive operations occur in an estimated 150 different four-digit SIC's, with metal finishing applied to hundreds of products. This analysis uses products and markets for final goods as the basis for dividing the metal finishing universe into sectors since they are the focus of the economic activity affecting the universe. This chapter characterizes the three sectors of the metal finishing universe in terms of economic significance, size, financial strength and competitive structure.

2. JOB SHOP SECTOR

A metal finishing job shop is defined as a firm whose primary operations are classified as SIC's 3471 or 3479, and which owns less than 50 percent of processed materials on an annual basis. There are an estimated 3099 firms performing regulated operations in these SIC's. 2734 are indirect dischargers and 365 are direct dischargers. In general, job shops are small, owner-operated, single-plant firms that provide metal finishing services to outside customers. The job shop industry sector appears to be competitive since it has a four firm concentration ratio of 7.2 percent in SIC 3471 and 15.1 percent in SIC 3479. The 1976-77 survey of the industry* indicated that the demand curve facing the industry is inelastic. The 424 owners surveyed reported that an average price increase of 10 percent did not have a measurable effect on quantity sold.

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* Data are from the U.S. Environmental Protection Agency's, Economic Analysis of Pretreatment Standards for Existing Sources of the Electroplating Point Source Category, August, 1979. Information on the characteristics of the metal finishing universe was derived from the 1976-77 survey of the industry.

Exhibit III-1 presents total employment, total sales and total plant water use characteristics of the job shop segment for establishments in various size ranges. The exhibit shows that a total of approximately 67,000 people are employed in job shops with an average of 22 employees per shop. The segment has sales of $3.1 billion with the average shop selling slightly more than $1 million. On a daily basis, the industry uses approximately 114 million gallons of plant water of which 90 million gallons is used for metal finishing production.

Exhibit III-1
Total Industry Employment
Sales & Water Use (000's)

Size Interval	Total Employment	Total Sales (1982$)	Total Plant Water
1-4	7.8	$ 54.0	13.9
5-9	9.8	40.1	15.3
10-19	11.6	53.0	17.7
20-49	16.7	78.0	38.7
50-99	13.9	50.4	22.6
100-249	7.4	34.5	5.7
	67.2	310.0	113.9

Exhibit III-2 presents a summary of typical balance sheet items for establishments in the job shop segment across various size ranges. The exhibit shows a linear relationship between the establishment size and dollar value for each item. The column labeled SD contains standard deviation measures for the total sample mean.

Of the 244 firms providing profit data, the mean profit before tax was $30,100 and the mean after tax profit was $15,600. Not all plants providing financial information had a profit in 1975. Sixty plants reported an operating loss. These losses averaged $4,400 on a before-tax basis and $3,400 on an after-tax basis.

Exhibit III-2
Typical Balance Sheet Items*

Item	Total Sample Mean	(SD)	1-19	20-99	100+
			Employment (000's Dollars)		
Current Assets	$380	$996	$196	$481	$2,793
Fixed Assets	334	574	131	526	1,459
Current Liabilities	218	524	101	323	1,163
Long-Term Debt	133	365	48	203	861
Net Worth	403	906	194	528	3,207

3. INDEPENDENT PRINTED CIRCUIT BOARD INDUSTRY

The Independent Printed Circuit Board Industry performs finishing operations similar to those performed by job shops.** Of the estimated total of 371 IPCBs, 327 are indirect dischargers and 44 are direct dischargers. Printed board shops are on average, larger than the typical job shop. Mean total employment is 60 people with 35 in production finishing. For the industry as a whole, this accounts for a total of 24,200 people with 13,100 in operations directly related to production of printed boards. These independent manufacturers have larger per plant sales than do the job shops. Only 35% sell less than $1.0 million annually while 43% sell over $2 million per year. Plant sales on average are $3.0 million with total industry sales estimated at $1.3 billion. IPCBs are financially stronger than job shops with average sales to fixed assets ratio of 6.8 compared with 3.8 for job shops, and profit to total assets ratio of 10 percent compared with 8 percent for job shops. Exhibit III-3 below shows average selected financial items of IPCBs derived from the 100 model plants.

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* Data derived from the 1976 survey of metal finishers. All dollar values have been adjusted to 1982 levels using the implicit price deflator, durable goods sector, contained in the Survey of Current Business, Bureau of Economic Analysis, U.S. Department of Commerce.

** Data on IPCBs were derived from the 1976 survey of the metal finishing universe.

EXHIBIT III-3

SELECTED FINANCIAL ITEMS - $1982 (000)

Income Items	
Sales	$3,040
Profit Before Tax	130
Profit After Tax	51
Balance Sheet Items	
Current Assets	$ 800
Fixed Assets	446
Current Liabilities	558
Long Term Debt	203
Net Worth	566

4. CAPTIVE SECTOR

Captive metal finishing operations occur in approximately 150 different four digit SIC's.* The Environmental Protection Agency estimates that 10,000** captive plants perform regulated processes. There are virtually hundreds of different products that are wholly or partially metal finished. Each one of these products has a unique price, demand, and demand elasticity. In the 1976-77 survey of captives it was found that 24 percent of the plants judge that their in-house metal finishing contributes at least 10 percent of the final cost of the finished good. For 40 percent of the sample, metal finishing's contribution to the value of the finished good was less than 3 percent. In general, captives use metal finishing as part of the production process for the purpose of protecting the final product and/or enhancing its aesthetic value.

Metal finishing application may occur in the same plant where the final good is produced, or the firm may use a specialized plant to provide finishing services to all its other plants. Captive plants that engage in metal finishing operations are rather large. One-sixth of all establishments (16.7 percent) have at least 1000 total employees, with 57 percent having between 100 and 999 employees. An average of 60 people are employed in metal finishing activities, while only an average of 20 people are employed in actual finishing operations. The average sales of a captive plant are $14 million a year, while the average sales of the whole firm are more than $50 million a year. Exhibit III-4 below summarizes the major characteristics of the captive universe.

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* Source - From a List of Subscribers for Products Finishing magazine in 1979.

** More detailed explanation follows in chapter IV.

EXHIBIT III-4

Characteristics of the Captive Universe

	I. Disch.	D. Disch.	Total
Number of Plants	7,500	2,500	10,000
Sales (Billions 1982 $)	127.2	41.8	169.0
Total Employment (000)	4,900	1,640	6,540
Employment in Metal Finishing Process (000)	450	150	600
Total Process Water Use (BGD)	3.6	1.5	5.1
Total Metal Finishing Water Use (BGD)	1.5	0.6	2.1

Source: 1976-77 Survey of Metal Finishers.

IV. ECONOMIC IMPACT METHODOLOGY

IV. ECONOMIC IMPACT METHODOLOGY

1. INTRODUCTION

Two distinct impact methodologies were designed. One examines impacts on the job shop sector and independent printed circuit board manufacturers, while the other analyzes the captive sector of the metal finishing universe. The rationale for this segmentation is summarized below:

- The job shop segment constitutes an identifiable sector (SIC's 3471/3479). It produces a final product which is metal finishing services. The captive sector is not an industry, but rather a metal-finishing process performed across 150 four-digit SIC's.
- A job shop faces a demand curve for its products while the demand curve facing a captive is for a final product. That is, the demand for metal finishing in captives is derived demand for production inputs.
- The prices for job shop services are determined by the market. However, there are no market prices for captive metal finishers. The prices of metal finishing services employed by captives are determined by accounting procedures and are used for internal transfers alone.
- The 1976-77 Survey of Metal Finishers provides an elaborate financial and economic data base for individual job shops and the entire job shop sector. The availability of data for the investigation of the captive sector was limited and the use of secondary data sources was extensive.
- The IPCB segment of the universe is similar to job shops in its characteristics. Most of the data elements that existed for job shops were also available for IPCBs.

Due to the above reasons, the job shop and IPCB impact methodology relied on the use of a capital budgeting model while the captive sector methodology is driven by price considerations.

2. JOB SHOP SECTOR AND IPCB METHODOLOGY

The job shop impact methodology centers around a plant closure model developed specifically for job shops in the metal finishing industry. The reason for pursuing a plant specific closure model is four-fold:

- Primary data on a large, representative sample of job shops had been gathered previously*.
- Critical data on a plant's fiscal condition and financial performance had been obtained for a sizable number of respondents.
- Plants are known to be small and undercapitalized, making cash flow and liquidity the key factors in their continued survival.
- Job shops can be defined as a discrete market and economic segment. Given that price rises can be computed directly and demand elasticity can be estimated reliably, a sound basis exists for forecasting the plants' direct response to incremental capital burdens.

Since the job shop sector is characterized by a large number of small, heterogeneous producers, the relevance of the impact methodology rests on meeting the following criteria:

- Primary surveys of plants and companies that establish the affected population and characterize accurately the industry's economic, fiscal and wastewater control position.
- Technical costing geared toward the unique conditions and needs of individual plants using cost and sizing rules that mirror the "real world".
- Estimation of candidates for closure based on an analysis of the price/cost impacts of the pollution control investment decision from the standpoint of owners, managers, competitors, customers, and lenders.
- Extrapolation of sample plant impacts to the industry as a whole based on a defensible decision rule that reflects accurately the dynamics of the marketplace; e.g., baseline closures, attrition rates, induced closures and new entrants.

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* Information gathered from the 1976-77 Survey of Metal Finishers.

The closure model developed for the job shop metal finishers is a financially driven set of operational analyses designed to identify economically disadvantaged firms by virtue of:

- Limited capital access or
- Insufficient profits.

Determinations of which firms would close are based on projections of what the firm's financial standing would be one year after the pollution control investment was made. The basic premise is that those future conditions would be evaluated by:

- A banker to determine if he would lend the firm sufficient funds for the investment, or by

- The owner(s) to determine if sufficient profits are projected to make it worthwhile for him (them) to remain in business, or whether the state of the business warrants an investment of further funds--called an equity infusion--into the firm in order to secure a bank loan.

These closure determinations are predicted by the closure model based on pro forma balance and income statement forecasts and quantitative decision rules. The methodology is developed in six steps:

- Determination of allowable price increase as reported by the individual job shop or average of job shops, interest rates and lengths of loans

- Forecast of financial statements

- Coverage ratio test

- Equity infusion test

- Profitability test for baseline closure determination

- Classification of firms.

(1) Determination of Variable Values

Exhibit IV-1, on the following page, displays the data and variables used by the model. The model accepts as inputs from the user the five variables shown. The first four--the interest rate and length of loans--are input as numbers; the fifth variable--allowable price increase--is a set of options including:

EXHIBIT IV-1

COMPUTERIZED FINANCIAL MODEL DATA AND VARIABLES

1. RESPONDENT PROVIDED DATA

Balance Sheet Data	Income Statement Data	Other Information
Current Assets	Depreciation	Ownership
Fixed and Other assets	Sales	Forecast Maximum Allowable Price Increase
	Owners Compensation	
Current Liabilities	Profit (Loss) Before Taxes	Number of Owners Who Work Full Time
Long Term Debt	Profit (Loss) After Taxes	

2. ADDITIONAL INPUT/VARIABLE DATA

Inputs	Variables
Pollution Control Capital Cost	Interest on Outstanding Debt
Pollution Control Operating Costs	Interest on Pollution Control Loan
	Remaining Length of Outstanding Debt
	Length of Pollution Control Loan
	Allowable Price Increase

3. OUTPUTS

Coverage Ratio (cash flow divided by fixed obligations
Profit after tax as percentage of:

- Sales
- Total assets
- Net worth

Profit after tax plus owners compensation as:

- A percentage of net worth
- Dollar per owner who works full time

Financial ratios such as:

- Debt percent
- Current ratio

Equity infusion required per working owner

Closure Classification

- Forecast price increase of respondent
- Average forecast price increase of respondents
- Cost pass through
- Weighted cost pass through.

Cost pass through is calculated as follows:

- Cost Pass Through = Pollution Control Cost x (0.2 + Loan's Interest - .02) + Pollution Control Operating Costs.
- Where the 0.2 reflects a 5 year depreciation schedule and the .02 a 5 year flow through of the investment tax credit.

Weighted cost pass through is the average of cost pass through of the 244 respondents weighted by sales values as follows:

$$\frac{\sum_{i=1}^{244} \text{Cost Pass Through } (i) \times \text{Sales } (i)}{\sum_{i=1}^{244} \text{Sales } (i)}$$

The cost pass through case is used to estimate price level changes. This assumes that each firm has sufficient market protection for that firm to pass its unique pollution control cost increase on to its customers; the aggregate industry-wide price increase, therefore, would be that of average cost producers.

(2) Forecast of Financial Statements

Two sets of equations are used to produce financial statements:

- Current statements are prepared using the respondent's balance sheet--taken directly from the survey (referenced above)--and supplemented by the calculations shown on Exhibit IV-2.
- Projected statements are prepared using the current balance sheet information and the input variables in the formulas shown in Exhibit IV-3.

EXHIBIT IV-2
Current Financial Statements

Using the respondent's questionnaire data and:

Tax Rate = 22% of first $75,000 of Profit (Loss) Before Taxes, and
43% of Profit (Loss) Before Taxes over $75,000

Cash Flow

Coverage Ratio

The following current financial measures are calculated:

$$\text{Profit (Loss) After Taxes} = \text{Profit (Loss) Before Taxes} \times (1 - \text{Tax Rate})$$

$$\text{Cash Flow} = \text{Profit (Loss) After Taxes} + \text{Depreciation}$$

$$\text{Coverage Ratio} = \text{Cash Flow} \div \frac{\text{Long Term Debt}}{\text{Remaining Length of Outstanding Debt}}$$

EXHIBIT IV-3
PROJECTED FINANCIAL STATEMENTS

1. Projected Income Measures

$$\text{Projected Depreciation} = \text{Depreciation} + \frac{\text{Pollution Control Capital Costs}}{\text{Length of Pollution Control Loan}}$$

$$\text{Projected Sales} = \text{Sales} \times \left(1 + \text{Allowable Price Increases}\right)$$

$$\text{Projected Profit (Loss) Before Taxes} = \text{Profit (Loss) Before Taxes} + \left(\text{Sales} \times \text{Allowable Price Increase}\right) - \left(\frac{\text{Pollution Control Capital Costs}}{\text{Length of Pollution Control Loan}}\right) - \left(\text{Pollution Control Capital Costs} \times \text{Interest on Pollution Control Loan}\right) - \text{Pollution Control Operating Costs}$$

$$\text{Projected Profit (Loss) After Taxes} = \text{Projected Profit (Loss) Before Taxes} \times \left(1 - \text{Tax Rate}\right) + \left(.02 \times \text{Pollution Control Capital Costs}\right)$$

$$\text{Projected Cash Flow} = \text{Projected Profit (Loss) After Taxes} + \text{Projected Depreciation}$$

$$\text{Projected Coverage Ratio} = \text{Projected Cash Flow} \div \left(\frac{\text{Long Term Debt}}{\text{Remaining Length of Outstanding Debt}} + \frac{\text{Pollution Control Capital Costs}}{\text{Length of Pollution Control Loan}}\right)$$

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2. Projected Balance Sheet

$$\text{Projected Current Assets} = \text{Current Assets}$$

$$\text{Projected Fixed and Other Assets} = \text{Fixed and Other Assets} + \text{Pollution Control Capital Costs} - \text{Projected Depreciation}$$

$$\text{Projected Current Liabilities} = \text{Current Liabilities} + \text{BALANCE}$$

$$\text{Projected Long Term Debt} = \text{Long Term Debt} + \text{Pollution Control Capital Costs} - \frac{\text{Long Term Debt}}{\text{Remaining Length of Outstanding Debt}} + \frac{\text{Pollution Control Capital Costs}}{\text{Length of Pollution Control Loan}}$$

$$\text{Projected Net Worth} = \text{Net Worth} + \text{Projected Profit (Loss) After Taxes}$$

Where if: $\text{Projected Current Liabilities} \geq 0$, then $\text{BALANCE} = \frac{\text{Long Term Debt}}{\text{Remaining Length of Outstanding Debt}} + \frac{\text{Pollution Control Capital Costs}}{\text{Length of Pollution Control Loan}} - \text{Projected Depreciation} - \text{Projected Profit (Loss) After Taxes}$

Otherwise if, $\text{Projected Current Liabilities} < 0$, then $\text{BALANCE} = \text{Projected Current Assets (New)} = \text{Projected Current Assets (Old)} - \text{Projected Current Liabilities (Old)}$

(3) Coverage Ratio Test

The coverage ratio is the projected cash flow divided by scheduled loan payments. If the projected coverage ratio is greater than or equal to 1.5, a firm is considered to be able to obtain a loan. This level is typical for small businesses, as long as the owner provides his guarantee. The 1.5 provides for some coverage of seasonal trends and temporary business down turns. If the projected coverage ratio is less than 1.5, then an equity infusion test is made.

(4) Equity Infusion Test

The amount of equity that the owner(s) would have to invest to qualify for a smaller loan, thus raising projected coverage ratio to 1.5, is defined as the equity infusion. An owner would invest equity infusion and borrow pollution control cost minus equity infusion. The test is that the owners would make the investment if they could maintain an income of $28,330* during the year of the investment. Thus, an equity infusion would be made if:

$$\frac{\text{Projected Profit After Taxes + Owners Compensation - Equity Infusion}}{\text{Number of Owners}} \quad \$28,330$$

(5) Profitability Test

No profitability test was incorporated into the model, but the following two rules were used to predict baseline closures:

- A baseline closure is a firm that would close regardless of the pollution control investment because of poor pre-investment profitability; defined as profit after tax + owner's compensation of less than $19,000 per working owner.

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* $15,000 was used as the cut-off in the Electroplating Pretreatment analysis. This figure is based on U.S. Bureau of the Census data which shows that $15,000 was the median family income in 1976. This explanation is part of the Electroplating Pretreatment record. The $28,330 figure adjusts $15,000 from 1976 to 1982 dollars using the Commerce Department's implicit price deflator.

- A baseline closure is a firm that would close if an imposition of $100 would result in a 1.0 or less coverage ratio.

(6) Classification of Firms

As a result of the foregoing tests--all of which are incorporated into the model except for the profitability test--the firms are classified into categories.

- Non-closure, no equity infusion needed
- Non-closure due to equity infusion
- Candidate for closure due to lack of profitability
- Candidate for closure due to lack of capital access
- Vulnerable firm on pre-investment basis, i.e., baseline closure.

The relationship between the model plants (i.e., plants which responded to the Survey with usable data) and the universe of job shops was established using variables and values provided from several sources. This analysis revealed that model plants show sufficient similarity to the universe to allow closures for the model plants to represent impacts in the universe on a directly proportional basis.*

Development of the extrapolation rules entailed several sequential steps summarized as follows:

- The number of baseline closures (i.e., plants likely to close prior to BATEA investment) was estimated.
- The model plant data base was corrected for the baseline closures. Of the 244 model

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* The same model plants were used in the analysis of the electroplating pretreatment regulation. The rationale and selection procedure for using these model plants are documented in Chapter IV and Appendix D of the Economic Analysis of Pretreatment Standards for Existing Sources of the Electroplating Point Source Category, EPA-440/2-79-031, August 1979.

plants, 28 were baseline closures (22 indirect dischargers and 6 direct dischargers.) In addition, 56 indirect discharging plants were projected as electroplating closures due to lack of capital access. This left 160 indirect discharging plants and 22 direct discharging plants for analysis of the effects of these regulations.

- Extrapolations from the model plant impacts to the corrected universe were conducted on a straight line basis.

The impact closure rate estimated by the closure routine was applied across the balance of job shops remaining after purging the universe of baseline closures. The rationale for this approach is that there is not sufficient sample data to support the development of a probability distribution from which unique closure probability estimates could be developed for selected plant characteristics, such as size, sales, water use, etc. Employing this technique does not alter the aggregate result, but may slightly over-or under-estimate the number of closures and primary economic impacts associated with a specific category of job shops. A more detailed presentation of the job shop model, its key assumptions, input variables, and logic is presented in Appendix B.

3. CAPTIVE SECTOR METHODOLOGY

Economic analysis of the captive metal finishing universe is complex. Captive metal finishing operations occur across 150 industries (four-digit SIC level). Each industry sells different types of products. Consequently, any one industry faces a unique demand curve for its products. Moreover, the economic structure of each industry varies, especially in degrees of competition and concentration ratios. In addition, individual firms within each industry face different demand elasticities. There are well established empirical techniques for the investigation of markets and for estimating demand and demand elasticities, but there are several difficulties involved with metal finished products:

- Output for metal finishing cannot be measured readily as it is not a final product; rather, it is an input into the production function with varying degrees of use in many final products.
- The prices of metal finished products vary with The elasticity of demand in their final use. The price charged by any one firm will depend on:

  - The extent of price or non-price competition in its industry
  - Types of manufacturing processes used in the industry
  - The availability of products substitutes
  - The geographic distribution of the firm's customers and suppliers.

- In captive firms there is no market price for metal finishing since all output is for intermediate consumption.

The analysis of the metal finishing industry is further complicated because individual firms process more than one product and use several types of metal finishing processes. Many firms can substitute between inputs, products, and processes to meet external requirements. Any substitution between products can change total revenues as well as operating and capital costs. A firm will not necessarily pass on this cost to consumers in the products most affected by the cost increases; rather, it will increase prices according to the elasticities of demand. The more inelastic the demand the more flexibility the firm has to increase the price.

In general, there are three methods available for estimating the impacts of pollution control expenditures. They are the following:

- A plant specific, financially driven closure model that assesses the cash flow and profitability of the plant under two conditions: pre- and post-expenditures for pollution controls. Plants whose cash flows and equity positions cannot support the purchase are judged candidates for closure. This is essentially the method that was used for the analysis of the job shop metal finishers.

- A general industry model that estimates the ability of industries and individual firms to pass on the incremental direct costs associated with pollution control expenditures. These models rely on the knowledge of the following:

  - Concentration in the industry
  - General structure of the industry
  - Industry growth trends
  - Prices of final goods

  - Prices of inputs
  - Production technology
  - Substitute products.

  In addition to the above, the analysis depends upon formulations of scenarios of demand elasticities and cross elasticities.

- A macro-economic approach which attempts to estimate the impact of the capital expenditures on the economy as a whole and derive values for the following variables:

  - Employment level in the economy
  - Price level [inflationary pressures]
  - Relative prices
  - Interest rates
  - Aggregate level of demand and supply
  - Capital availability.

None of the approaches cited above were used in their pure form in this analysis due to the following reasons:

- Plant specific financial or operating data do not exist for cases at the four-digit SIC level.

- With more than 150 four-digit SIC industries a sector analysis is not cost-effective.

- Adopting a macro approach similarly poses limitations for this analysis. Not only are the available macro models static, they often require input specifications for demand coefficients or price changes, the very factors one wishes to predict. Moreover, macro models are insensitive to small price changes (as is the case here) and thus their application is unwarranted.

The chosen approach is effectively a blending of methods which best satisfies the prevailing data constraints. This analysis relies on a sample of plants (1087) for which key data requirements are available with the use of simplifying yet realistic assumptions.

The impact of the pollution control expenditures on an individual plant is estimated by comparing the individual plant cost increase due to pollution control costs with the average cost increase that will occur industry wide. The potentially impacted firms are those which experience cost increases in excess of the industry's average. It is expected that firms with a ratio of pollution control expenditures to total revenues which significantly exceed the industry average will not be able to raise prices by an amount (percent) equal to their added costs. These plants are singled out as potentially impacted firms.

The plant impact routine which is illustrated by the flow chart in Exhibit IV-4 on the following page identifies those captive firms which are candidates for further analysis because their cost increases exceed the industry average cost increase. The following steps explain in some detail the logic of the routine.

- The routine is based on information available from the 1976-77 Survey of Metal Finishers from which key data are present for 1087 plants.

- The sample of 1087 plants is first divided into two groups by mode of discharge:

    - Direct dischargers (270 plants)
    - Indirect dischargers (817 plants).

- Per plant investment cost tables which relate metal finishing waterflow to cost are read into the computerized routine. A different table is read for each option. The routine matches each model plant's waterflow with the table and assigns investment costs. The cost tables are displayed in Appendix C.

- Each plant's estimated capital pollution control expenditure is then annualized* and divided by the plant's value of sales to obtain the price increase necessary to cover the added costs of pollution control for each individual plant. To clarify, the cost increase per plant is computed as,

$$\text{Cost Increase} = \frac{\text{Annual Pollution Control Costs}}{\text{Value of Sales}}$$

- The cost increase for the total population of plants is then computed by summing the annual pollution control costs of all plants and dividing by the summation of the total sales of all plants.

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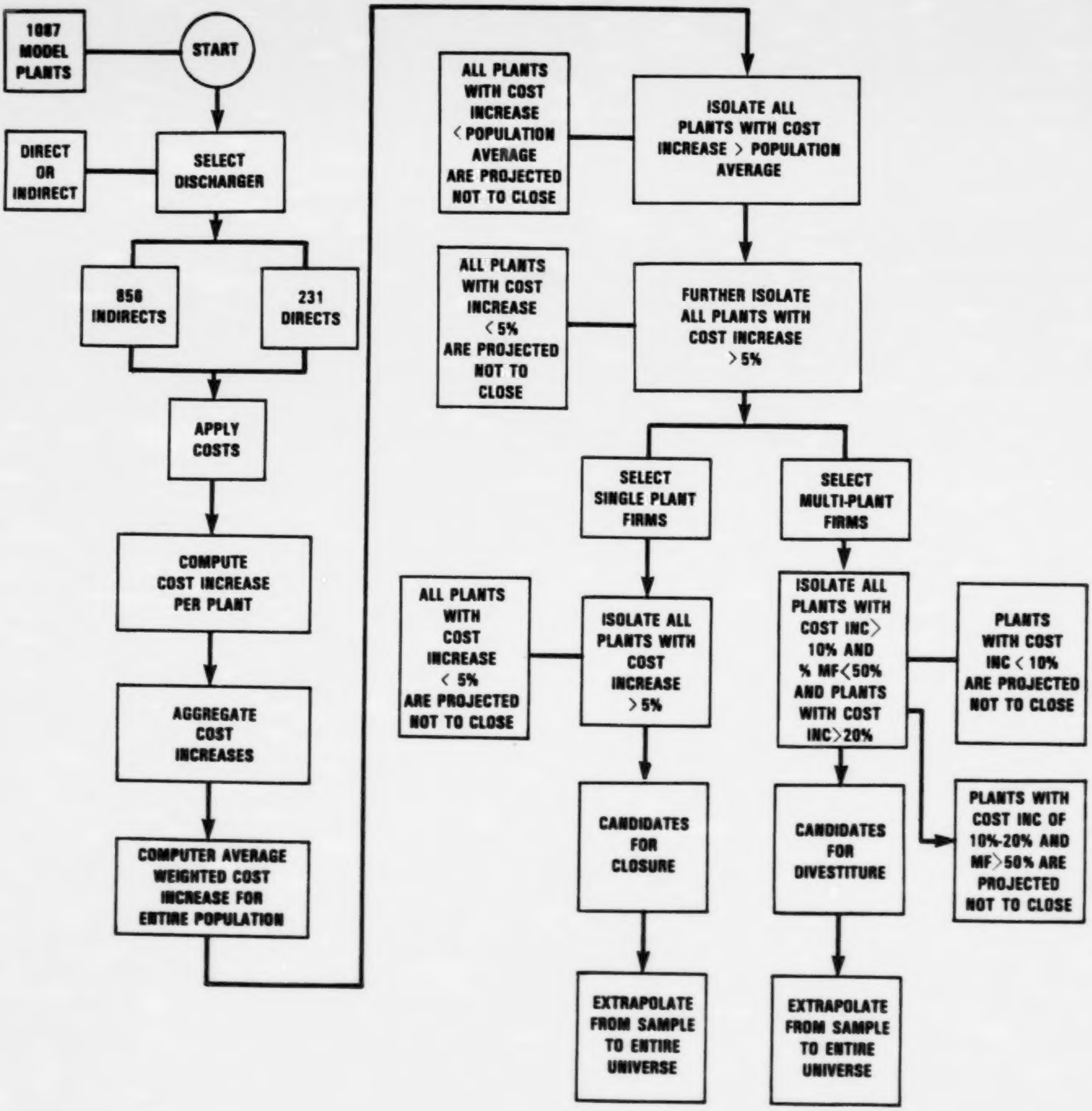
* Annualization computations assumptions are described in Appendix A.

EXHIBIT IV-4

FLOWCHART OF THE CAPTIVE PLANTS CLOSURE ROUTINE


1087 MODEL PLANTS
START
DIRECT OR INDIRECT
SELECT DISCHARGER
856 INDIRECTS
231 DIRECTS
APPLY COSTS
COMPUTE COST INCREASE PER PLANT
AGGREGATE COST INCREASES
COMPUTER AVERAGE WEIGHTED COST INCREASE FOR ENTIRE POPULATION
ALL PLANTS WITH COST INCREASE < POPULATION AVERAGE ARE PROJECTED NOT TO CLOSE
ISOLATE ALL PLANTS WITH COST INCREASE > POPULATION AVERAGE
ALL PLANTS WITH COST INCREASE < 5% ARE PROJECTED NOT TO CLOSE
FURTHER ISOLATE ALL PLANTS WITH COST INCREASE > 5%
SELECT SINGLE PLANT FIRMS
SELECT MULTI-PLANT FIRMS
ALL PLANTS WITH COST INCREASE < 5% ARE PROJECTED NOT TO CLOSE
ISOLATE ALL PLANTS WITH COST INCREASE > 5%
ISOLATE ALL PLANTS WITH COST INC> 10% AND % MF<50% AND PLANTS WITH COST INC>20%
PLANTS WITH COST INC < 10% ARE PROJECTED NOT TO CLOSE
CANDIDATES FOR CLOSURE
CANDIDATES FOR DIVESTITURE
PLANTS WITH COST INC OF 10%-20% AND MF>50% ARE PROJECTED NOT TO CLOSE
EXTRAPOLATE FROM SAMPLE TO ENTIRE UNIVERSE
EXTRAPOLATE FROM SAMPLE TO ENTIRE UNIVERSE

- The entire population is divided into those plants with projected cost increases lower than the sample average and those higher than the sample average. Those plants with projected cost increases less than the average were considered to experience minor economic impact and flagged out as non-closures.

- Plants with increases greater than the industry average are further distinguished according to those with a projected cost increase of greater than either the sample average or five percent, whichever is larger. The five percent figure was chosen because a five percent price increase is considered a major change, as it is significant enough to alter demand-supply relationships.

- All the plants with price increases greater than 5 percent are divided into those which are multi-plant corporations and those which are single plant corporations. A multi- plant corporation is one where the production process is performed in more than one plant. In these cases the firm uses one, or any one of its plants for performing metal finishing services for all its products. A single plant corporation is one that operates only a single plant and metal finishing is a major part of the production process. The segmentation of the plants into multi-plant companies and single plant firms was done for the following reasons:

    - Multi-plant firms' structure indicates an economic and/or financial advantage in having a captive metal finishing operation.

    - The annual pollution control cost for a plant which is part of a multi-plant firm is very small relative to the firm's value of sales.

    - Multi-plant corporations have a greater access to capital due to their size.

- All single plant firms were singled out as candidates for closure if the projected cost increase was greater than 5 percent. A firm with a five percent cost increase is assumed to be unable to compete in an industry where the average price increase is less than one percent.

All multi-plant corporations are singled out as candidates to divest their captive operation if the projected price increase in the captive plant is 10 percent or more and the percentage of products receiving metal finishing is less than 50 percent of the products produced in that plant. As mentioned above, multi-plant corporations are not as vulnerable to the rising costs of production and thus would only divest their metal finishing operation under extreme conditions. A captive plant that metal finishes less than 50 percent of its products and has an overall price increase of more than 10 percent due to metal finishing pollution control costs will effectively experience a 20 percent increase in the cost of the metal finishing process. Thus, it will have a great incentive to contract out its metal finishing operations or do away with the process altogether in favor of a less costly alternative.

A detailed description of the computerized routine, its logic, variables, and cost inputs is presented in Appendix C.

In addition, an analysis of secondary impacts on final consumption goods is carried out with the use of an input-output (I/O) analysis. (I/O model is discussed in detail in Appendix A.)

V. REGULATORY OPTIONS AND DERIVATION OF COMPLIANCE COSTS

V. REGULATORY OPTIONS AND DERIVATION OF COMPLIANCE COSTS

Effluent treatment options and their associated costs form the basis for the assessment of the economic impacts of water pollution controls. This chapter addresses the following:

- Regulatory options
- Derivation of compliance costs
- Derivation of the size of the affected universe.

1. REGULATORY OPTIONS

The Environmental Protection Agency evaluated two regulatory options for existing industrial sources. A third option was also evaluated for new sources. Each option sets a compliance standard and assigns specific pollution abatement equipment.

- Option I control includes:
  - Precepitation/clarification
  - Hexavalent Chrome Reduction
  - Alkaline Chlormation
  - Sludge Dewatering
  - No dumping of total toxic organics.
- Option II equipment includes all the equipment and requirements necessary to meet Option I, with the addition of a multimedia-filtration unit.
- Option III equipment includes all the equipment necessary to meet Option I plus in-plant controls on cadmium.

The pollution control equipment requirements are the same for both job shops and captives.

2. DERIVATION OF COMPLIANCE COSTS

The derivation of water pollution control costs differs somewhat between job shops, IPCBs, and captives.

(1) Job Shop and IPCB Plant Costing

Information from the 1976-77 Survey of Metal Finishers on 244 job shop model plants and 100 IPCB model plants in the data base was submitted to Hamilton standard for costing. Each plant was run individually through the technical contractor's cost generating program. The key parameters considered were:

- Flow constituents
- Plant layout
- Materials finished
- Hours of operations
- Finishing processes
- Amperage, thickness of plate
- Equipment in place
- Tooling, piping
- Construction, laboratory costs.

Except for the control of total toxic organics, all direct discharging job shops are in compliance with option I requirements. Therefore, direct discharging job shops were costed only for compliance with the TTO limit and the marginal cost of achieving Option II compliance requirement from Option I requirements. An estimated 15.5 percent or 56 of the direct discharging facilities may be required to baseline monitor for TTO and 2.8 percent or 10 facilities are projected to compliance monitor for TTO. Baseline monitoring costs are $1,904 per facility while annual compliance costs are $2,890 per facility. All 365 direct discharging job shops were costed for a multimedia filtration unit under Option II. (A detailed description of the cost generating program is provided in Appendix B.)

Indirect discharging job shops and IPCBs were costed only for baseline and compliance monitoring of total toxic organics. A total of 15.5 percent or 424 of the job shops were assumed to baseline monitor on a one time basis, and 2.8 percent (or 77) may have to compliance monitor on an annual basis. All IPCBs were assumed to baseline monitor and 27 percent were assumed to monitor for compliance.

(2) Captive Plant Costing

Information on processes of captive plants was not available from the 1976-77 Survey of Metal Finishers. As a result the technical contractor developed cost estimates on its own sample of 100 indirect discharging captive model plants and 100 direct discharging captive model plants. Each plant in the sample was costed by the technical contractor's costing program for both Option I and Option II compliance requirements.

The technical contractor also developed costs for the electroplating flow of each indirect discharging model plant in its sample. This was done to isolate the electroplating portion of the metal finishing flow which was costed in an earlier electroplating pretreatment regulation.

The technical contractor's model plants were then linked to the economic data base on the basis of water flow -- the common variable. Total plant flow was not functionally related to previously regulated flow. Thus a strong functional relationship could not be established on a plant-by-plant basis between the technical contractor's plant water flow and estimated metal finishing investment costs. Instead, the model plants were grouped into water usage categories (separate for each discharging mode) with their corresponding costs. These groupings established a relationship between water usage and costs so that the model plants in the economic data base could be costed. These cost groupings are displayed in Appendix C.

(3) Costs Associated With Compliance With the Total Toxic Organic Limit

The Agency does not expect facilties using solvents to incur additional costs to dispose of these solvents because solvent wastes can be recovered profitably by plants or sold to waste haulers. All facilities using toxic organics were assumed to incur baseline monitoring costs, however. Additionally, the economic analysis assumes that a portion of those using toxic organics will annually incur compliance monitoring costs.

- Baseline Monitoring Costs

  Solvent solutions are the major potential source of TTO violations. Currently 24% of the capitive faciities perform solvent degreasing. The economic analysis assumes that facilities performing solvent degreasing will be required to conduct an initial baseline monitoring. This assumption somewhat overstated the actual number of facilities performing the initial monitoring because some solvent degreasers may use non-toxic solvents and be excluded from the initial monitoring. However, there are other, less significant, potential sources of toxic organics besides solvent degreasing. To account for these other potential sources, the Agency increased the number of plants which reported performing solvent degreasing by 50 percent. This increased (36 percent) figure was used as a conservative estimate of those facilities that will need to submit a baseline monitoring report.

- Compliance Monitoring Costs

  Most facilities are expected to be able to use a certification procedure in lieu of compliance monitoring. To account for the possibility of control authorities requiring compliance monitoring, the agency used the percent of those facilities performing solvent degreasing which dump their solvents as its estimate of the percent of plants needing to compliance monitor. Currently 24 percent of plants perform solvent degreasing and 27 percent of the plants performing solvent degreasing dump their solvents; therefore, 6.5 percent (27 x 24 percent), is the percent estimated to compliance monitor. It is likely that most of these facilities will cease dumping toxic organics. Thus the estimate probably overstates the likely compliance costs.

The same procedure was used to estimate monitoring costs for job shops and independent printed circuit board manufacturers. The percent of job shops performing solvent degreasing was 10.3%; that for IPCB manufacturers was 100%.

The resulting costing assumptions for all three segments follow:

Percent of Universe Affected

	Job Shops	IPCB	Captives
Baseline Monitoring	15.5%	100%	36%
Compliance Monitoring	2.8%	27%	6.5%

3. ESTIMATION OF THE SIZE OF THE UNIVERSE

The agency relied primarily on the Permit Compliance System (PCS) File for the estimation of the captive metal finishing universe. That file was also used to estimate a total of 365 direct discharging and 2734 indirect discharging job shops in SIC's 3471 and 3479.

The PCS File showed that there are approximately 2,500 direct discharging captives in SIC's 25-39 that will be covered by the metal finishing effluent guidelines. Most of these plants are in SIC's 34-39. The 1976-77 Survey of Metal Finishers indicated that there were three times as many indirect dischargers as direct dischargers, and thus, it was determined that there are 7,500 indirect discharging captives in the metal finishing universe. The same ratio of direct to indirect discharging job shops was used to estimate the size of the indirect discharging sement.

(1) Segment of the Universe Affected By This Regulation

Not all of the estimated 13,500 metal finishing establishments will need to make additional Investments in order to comply with this regulation. The Environmental Protection Agency conducted three surveys to update information on pollution control equipment in place.* The results of these surveys were incorporated into the agency's estimates of the affected universe. The affected universe is as follows:

- Direct Discharging Job Shops - the surveys conducted by the agency determined that none of the 300 direct discharging job shop will have to invest in order to comply with Option I Standard, except for monitoring of total toxic organics. One time baseline monitoring may be required for 56 of the job shops, and 10 job shops may have to compliance monitor on an annual basis. All 365 job shops would have to make additional investments in order to meet Option II requirements.

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* The results of the first survey are outlined in a July 30, 1981 memorandum from Mr. Richard Kinch to Mr. Art Berman. The second survey's sample design and selection procedure is described in an August 20, 1981 memorandum from Mr. Richard Kotz to Mr. David Pepson. The results of the survey are contained in a memorandum from Mr. Henry D. Kahn to Mr. David Pepson. The results of the last survey are described in a memorandum dated December 3, 1981 from Mr. Kinch to Mr. Berman.

- Indirect Discharging Job Shops. - All 2734 indirect discharging job shops are already covered by the electroplating pretreatment regulation. These job shop will not be required to invest additional funds to meet Options I or II of this regulation. They may, however, be required to monitor for total toxic organics. It is estimated that 424 indirect discharging job shops may have to baseline monitor, and 77 may have to monitor for compliance.

- Direct and Indirect Discharging Independent Printed Circuit Board Manufacturers. - Based on information collected during an earlier electroplating study this agency determined that a total of 371 IPCBs will be affected by this regulation. A total of 327 are indirect dischargers and 44 are direct dischargers. All 371 IPCBs may be required to baseline monitor for TTO and 27 percent or 88 indirect dischargers and 12 direct dischargers may have to compliance monitor annually.

- Direct Discharging Captives - Agency surveys determined that all 2500 direct discharging captives have the necessary equipment in place to meet Option I requirements, except for compliance with the TTO limits. A total of 900 direct discharging captives may be required to baseline monitor for total toxic organics and 162 of the 900 may need to monitor for compliance annually. All direct discharging captives would have to make additional investments to meet Option II compliance levels.

- Indirect Discharging Captives - The Agency's technical data base indicated that half (3750) of the 7500 indirect discharging captives are integrated plants and half (3750) are non-integrated. The electroplating pretreatement regulation covers all process flows at the nonintegrated plants, except for plants with process water usage of less than 10,000 G.P.D. A total of 912 of these plants will have to make investments in order to comply with Option I requirements. The electroplating standards also regulate the electroplating processes of the integrated plants. Agency surveys determined that of the 3750 integrated plants:

- 17 percent will not need to install treatment because they meet EPA limitations through the use of in-process controls.
- 51 percent have already installed Option I level pollution treatment equipment for all relevant processes.

This leaves 1200 integrated plants with water usage of more than 10,000 G.P.D. that EPA estimates will bear additional costs to meet Option I standards.

A total of 2700 indirect discharging captives may be required to one-time baseline monitor for total toxic organics, and 487 of those may need to monitor for compliance. The analysis assumes all indirect discharging captives would have to make additional investments to meet Option II compliance levels.

VI. ECONOMIC IMPACTS

VI. ECONOMIC IMPACTS

The estimated economic impacts of Option I compliance levels and Option II compliance levels are presented below. Compliance with Option I standards will have very small effects on the metal finishing universe, while compliance with Option II would have measurable impacts.

1. BASELINE CONDITIONS

Baseline conditions for both job shops and captives were factored into the analysis in order to isolate the impacts of the metal finishing regulation on the universe.

(1) Job Shop Baseline Conditions

All indirect discharging job shops are regulated by the electroplating pretreatment regulations, therefore, the job shop closure model was operated to factor out all model plants which were forecasted to close due to either a poor financial position before investment in electroplating compliance or because of their inability to meet compliance requirements. Of the 216 indirect discharging model plants 56 were judged as baseline or electroplating closures and dropped from the sample. The remaining 160 model plants were assumed to represent the indirect discharging job shop universe and the results extrapolated in a straight line. For the direct discharging job shop population, 6 baseline closures were dropped from the sample of 28 model direct discharging job shops.

(2) IPCB Baseline Conditions

A total of 40 IPCB model plants had all the financial data needed for impact analysis. A total of 5 model plants were baseline closures and 1 plant was judged as a closure due to the electroplating pretreatment regulation. The remaining 34 model plants were assumed to represent the IPCB segment of the universe and the results extrapolated in a straight line.

(3) Captive Baseline Conditions

The indirect discharging segment of the metal finishing industry is also covered by the Electroplating Pretreatment regulation promulgated by EPA in

1979. The baseline costs for this segment of the metal finishing population have been reassessed since the 1979 electroplating analysis. The current estimates -- derived by employing assumptions identical to those for deriving the metal finishing costs and using 1982 as the baseline year -- are $512 million in capital costs and $169 million in annual costs. As a result of these compliance expenditures; EPA estimates that the 1979 electroplating standards could cause 24 baseline plant closures and 6 electroplating process line divestitures. Because the process coverage of the Metal Finishing regulation is more comprehensive, it will require an additional capital investment for approximately 16 percent of all indirect discharging plants with water usage greater than 10,000 G.P.D., and 32 percent of plants with water usage less than 10,000 G.P.D. A vast majority of the metal finishing plants will not need an additional investment in treatment technology because they:

- Have only electroplating process flows and are therefore completely covered by the Electroplating Pretreatment regulation. (Except plants using less than 10,000 G.P.D.)
- Have already installed pollution control equipment that treats all their metal finishing processes
- Have in-plant "process" controls that treat process flows sufficiently to meet proposed EPA Limitations.*

For those plants requiring an additional investment in pollution control equipment, electroplating compliance costs are factored into the baseline conditions. The costs attributable strictly to this Metal Finishing regulation are then added on so that incremental economic impacts can be measured. In other words, impacts on the model plants were studied first with the costs of compliance of the electroplating flow alone. Those model plants that were projected to close under electroplating costs were judged as baseline closures. A model plant projected not to close with electroplating costs alone but projected to close with the sum of electroplating and metal finishing costs was judged a metal finishing closure. Examples of an electroplating baseline closure and a metal finishing closure are presented below:

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* This is based on EPA surveys of the metal finishing industry.

- Model plant number 250 in Exhibit C-8 uses 50,000 gallons per day in its total metal finishing process. The electroplating process annual compliance costs are estimated to be $63,100 (Exhibit C-5) and the metal finishing process compliance costs are estimated to be $41,330. This plant is considered as a baseline closure since it will experience a 6.3 percent cost increase with electroplating costs and 10.4 percent increase with the combined electroplating - metal finishing costs.

- An example of a model plant which is judged to be a metal finishing closure is plant number 113 in Exhibit C-4. This plant is estimated to incur $1904 in TTO baseline monitoring costs and $154,814 in equipment costs to comply with Option II. This plant is projected to close since it is a single plant firm with sales of 1 million annually and an estimated cost increase of about 15 percent.

2. CAPITAL AVAILABILITY CONSIDERATIONS

The job shop methodology explicitly takes into consideration the ability of plants to finance new investments. In fact, the closure model is based on financial variables. In general, the small relative magnitude of these investments will not have a measurable impact on capital or financial markets.

Total annual compliance investment for captives is $351.0 million. This is compared to total investment in plant and equipment for SICs 34-38, estimated for 1982 by Data Resources Incorporated, as being $46.6 billion.*

Compliance investment is less than 0.3 percent of total industry investment. This is a relatively small proportion of total investment, and should not affect capital availability or long-term capital growth in the industry.

3. ESTIMATED IMPACTS OF OPTION I

Exhibit VI-1 on the following page displays the investment and annual costs associated with option I compliance requirements. The total investment cost necessary to comply with the metal finishing regulation is estimated at $351 million with annual costs of $118.0 million. The

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* U.S. Long-Term Review, Data Resources, Inc., Table 3-7, p. 1.69.

(1) Direct Discharging Job Shops

No establishments in this segment will be required to make capital investments in order to meet option I compliance level. A total of 10 direct discharging job shops may have to compliance monitor for total toxic organics at an estimated total annual cost of $29,000. A total of 56 job shops may have to baseline monitor at an estimated $108,000 no closures are forecast for this segment. The average cost of production are estimated to increase by 0.02 percent.

(2) Indirect Discharging Job Shops

Indirect discharging job shops will not have to make capital investments to meet option I compliance levels. A total of 424 shops may have to baseline monitor for TTO at a one-time cost of $807,000, and 77 shops may have to compliance monitor annually at a cost of $220,000. The per plant annual costs of $2890 are expected to increase the cost of production by 0.02 percent. No closures are expected in this segment.

Since the compliance date is set for the year 1986, it was assumed that job shops will baseline monitor before that year and that the costs for the two monitoring functions will not occur in the same year. If the two monitoring functions had occurred in the same year, one job shop might have closed.

(3) Direct Discharging Independent Printed Circuit Board Manufacturers

The only additional requirement for this segment of the universe will be control of total toxic organics. All 44 IPCBs may have to baseline monitor at a cost of $83,700 and 12 will have to compliance monitor annually at an estimated cost of $34,700. Cost of production are estimated to increase by 0.03 percent. No IPCBs will close due to the monitoring requirements regardless of compliance dates.

(4) Indirect Discharging Independent Printed Circuit Board Manufacturers

Indirect discharging IPCBs will be required to control total toxic organics. All 327 may have to baseline monitor at a one time cost of $623,000. A total of 88 indirect discharging IPCBs are assumed to require compliance monitoring at an estimated annual cost of $254,000 for this segment. Cost of production are estimated to increase by 0.03 percent. No IPCBs will close due to the monitoring requirements.

(5) Direct Discharing Captives

Except for compliance with the TTO limit, direct discharing captives have all the necessary equipment in place to meet option I compliance requirements. A total of 900 direct captives are assumed to be required to baseline monitor at an estimated one-time cost of $1.7 million. In addition, 162 of the 900 may have to compliance monitor at a total annual cost of $468,000. No plant closures are forecast for this segment, and the estimated production cost increase is 0.01 percent.

(6) Indirect Discharging Captives

Total investment cost for this segment is estimated at $351.0 million with annual costs of $118.0 million.* Baseline monitoring for total toxic organics may affect 2700 plants (including the 1020 plants with less 10,000 G.P.D.) with a cost of $5.1 million. Annual compliance monitoring is assumed to affect 487 indirect captives with an estimated cost of $1.4 million. No closures or divestitures are forecasted for indirect discharging captives. Cost of production is estimated to increase by 0.2 percent.

1. Indirect Discharging Captives With Water Usage of Less Than 10,000 G.P.D.

This segment of the affected universe which is made up of 2850 non-integrated indirect discharging captives will be required to invest in option I equipment as well as monitor for total toxic organics. A total of 912 plants (32% of population) may have to make the investment in equipment. Total capital investment costs are estimated to be $35.9 million with annual costs of $11.8 million. The one time baseline monitoring costs for total toxic organics will affect 1026 plants with costs of $1.9 million. Annual compliance monitoring costs for total toxic organics will come to $500,000 affecting 185 plants. No plant closures are forecasted for this segment. Cost of production will increase by less than 1 percent, with a range of 0.01 percent to 1 percent.

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* This cost includes $5.4 million RCRA total compliance costs. These costs were generated by the technical contractor and are factored into the annual costs of model plant.

4. ESTIMATED IMPACTS OF OPTION II

Exhibits VI-1 and VI-2 summarize the estimated costs and impacts of complying with option II. The investment costs for option II are estimated at $1510.6 million with annual costs of $502.1 million. A total of 50 direct discharging job shops are forecast to close. This would imply an employment loss of 1365 workers and a cost increase of 4 percent of total sales. Direct discharging captives will experience 21 plant closures and 10 divestitures, with an employment loss of 760 and a cost increase of 0.5 percent. Indirect discharging captives will experience 8 plant closures and employment loss of 185.

The overall industry impact of filtration would be a closure rate of 0.8 percent and an employment loss of 0.4 percent; the direct discharging job shop sector, however, would experience a disproportionate burden: a closure rate of 14 percent and an employment loss of 19 percent.

5. ESTIMATED SECONDARY PRICE IMPACTS

The secondary price impacts were derived with the use of an input-output analysis. The analysis estimates the inflationary impact of a change in the price of metal finishing services. The input-output analysis, explained in Appendix E, provides a method of examining in a simple but quantifiable way the relationship between prices in a particular economic system. It makes possible an estimate of the consequences of a change in any one price upon the others in the system. (Appendix A provides a detailed exposition of the input-output model). The input-output analysis assumes that all increases in costs, direct or indirect, are passed on: i.e., that each sector raises the price of its primary inputs, plus the rise in the price of the inputs absorbed from other industries. This assumption gives an upper-bound on closure estimates. It is important to note that the input-output model employed assumes that the whole economy could be adequately represented by static input-output technical coefficients. Therefore, estimation results based on the I/O model should be read with this inherent limit in mind.

Exhibits VI-3 and VI-4 show the secondary price impact on the following:

- SIC's 34-39
- Personal consumption expenditures
- Gross private fixed capital formative
- Net exports
- Total federal government purchases.

EXHIBIT VI-1
TOTAL INVESTMENT AND ANNUAL COSTS BY OPTIONS
(Million of 1982 $)

OPTION I	D.D. JOB SHOPS	I.D. JOB SHOPS	IPCB	D.D. CAPTIVES	I.D.** CAPTIVE	TOTAL
Investment Costs	0	0	0	0	351.0	351.0
Annualized Investment Costs	0	0	0	0	115.6	115.6
TTO Annual Costs	.02	.2	.3	.5	1.4	2.4
TTO Baseline Costs	.08	.8	.8	1.7	5.1	10.4
Total Annual Costs (Including TTO Costs)	.02	.2	.3	.5	116.6	118.0
OPTION II						
Investment Costs	18.6	0	0	442	1050	1510.6
Total Annual Costs*	6.1	.2	1.1	146	348.6	502.1

* Includes total toxic organics monitoring costs.

** Includes Indirect Discharging captives with water usage less than 10,000 6.P.D. Total investment and annual costs (in millions of $) for I.D. captives with flow of less than 10,000 G.P.D. under Option I are as follows: investment costs $35.9, annualized investment costs $11.8, TTO annual costs $0.5, TTO baseline costs $1.9, total annual costs $12.0. Under Option II the costs (in millions of $) are: investment costs $73, and total annual costs $21.

EXHIBIT VI-2
ESTIMATED IMPACTS OF REGULATORY COMPLIANCE

OPTION I	D.D. JOB SHOPS	I.D. JOB SHOPS	IPCB	D.D. CAPTIVES	I.D.* CAPTIVE
Plant Closures	0	0	0	0	0
MF Divestitures	0	0	0	0	0
Employment Loss	0	0	0	0	0
% Cost Increase	0.02	0.02	0.03	0.01	0.2
OPTION II					
Plant Closures	50	0	0	21	8
MF Divestitures	0	0	0	10	0
Employment Loss	1365	0	0	760	185
% Cost Increase	4	0.1	0.1	0.5	0.6

* Includes Indirect Discharging captives with water flow less than 10,000 GPD. Regulatory compliance of I.D. captives with flows of less than 10,000 G.P.D. under both options I and II will result in no plant closures, MF divestitures or employment losses. The average cost increase under both options is 1 percent.

EXHIBIT VI-3

ESTIMATED PRICE INCREASES FOR 2-DIGIT SIC'S (IN PERCENT)

SIC	OPTION I	OPTION II
34	0.1	0.3
35	0.1	0.3
36	0.05	0.2
37	0.05	0.1
38	0.05	0.1
39	0.05	0.2

EXHIBIT VI-4

ESTIMATED TOTAL PRICE IMPACT OF EPA BATEA METAL FINISHING REGULATIONS ON PRINCIPAL FINAL DEMAND COMPONENTS

FINAL DEMAND SECTORS	PERCENTAGE PRICE INCREASE	
	Option I	Option II
Personal Consumption Expenditures	0.01	0.02
Gross Private Fixed Capital Formation	0.005	0.01
Net Exports	0.01	0.02
Total Federal Government Purchases	0.007	0.01

VII. REGULATORY FLEXIBILITY ANALYSIS

VII. REGULATORY FLEXIBILITY ANALYSIS

The Regulatory Flexibility Act (Public Law 96-354) is a regulatory reform initiative designed to ensure that, while achieving statutory goals, regulations do not impose unnecessary costs on "small entities." Small entities are defined in Section 2(a)(3) as "small businesses, small organizations, and small governmental jurisdictions with limited resources." The analytical requirements for regulatory flexibility analysis are enumerated in Sections 603 and 604 of this statute. Section 605(b) qualifies these requirements and states that:

> "Sections 603 and 604 of this title shall not apply to any proposed or final rule if the head of the agency certifies that the rule will not, if promulgated, have a significant economic impact on a substantial number of small entities."

Option I, the selected option, will affect the following segments of the metal finishing unvers:

- Indirect discharging captives
- Direct discharging captives
- Indirect discharging job shops
- Direct discharging job shops
- Printed circuit board.

The economic impact analysis set forth in this document indicates that for Option I there will be no economic impacts in terms of plant closures for any metal finishing establishments, including those affected that are considered to be small entities. Thus, there will not be "a significant economic impact on a substantial number of small entities." However, an investigation into regulatory flexibility issues has been undertaken. These issues include:

- Definition of a small firm
- Establishment of an "optimal" small firm criterion
- Regulatory impacts on small firms.

1. DEFINITION OF A SMALL FIRM

In considering reasonable definitions of small firms in the metal finishing industry, four separate approaches appeared promising. The four methods considered the following criteria:

- Number of employees, using either total employment or metal finishing production employees

- Sales volume or value added by manufacturing

- Pollution generation volume either in terms of metric tons of contaminant or types of contaminants in the wastestream

- Production/process water volume in gallons per day.

Several problems are apparent with each index, although a basis for selecting one, the last criterion, is readily defensible. Briefly, the operant difficulties in relying on these measures include:

- Number of employees in the firm does not show a large positive correlation with sales of the firm. Businesses with relatively few employees can generate sales volumes greater than that of a plant with ten times the employment. The problem here is plant technology and automation levels. In metal finishing a highly automated plant could be a production giant, yet appear, on the basis of employment, to be a small business.

- Dollar volume in sales or value added is equally unsatisfactory due to the fact that by itself it fails to reflect market vulnerability. As SBA has long maintained, a small business is small only in relation to its competitors. Small in this sense means lacking the stature to influence price or production trends in the industry. There is no obvious basis for establishing any sales level as a distinguishing cut-off for a small firm in this industry because of the heterogeneity of the producers.

- For regulatory purposes establishing pollution generating volume is a highly relevant factor for defining plant size. Regardless of employment or sales, plants generating large hazardous waste volumes are of more importance than those generating trivial quantities. The problem here is that waste volume is a function of many plant-specific considerations (processes, chemicals, and operations), and data on a plant's pollution volume are not readily available.

- Plant water volume correlates moderately well with both employment and sales. while not a predictor of economic size, water volume is at least associated with plant economics. Additionally, plant water volume correlates with but does not predict pollution generation volume. It serves, therefore, as a reasonable measure of plant size both on economic and technological grounds.

Extensive sensitivity analysis performed in the economic impact analysis for the earlier electroplating pretreatment regulation showed that the most vulnerable plants had a water flow level of less than 10,000 G.P.D. EPA, therefore, chose plant water volume as the primary criterion to use in assessing the economic impact on a substantial number of small entities. It selected the 10,000 G.P.D. flow level used in the earlier Electroplating Pretreatment Regulation as the cut-off level for identifying potential small business economic impacts.

2. REGULATORY IMPACTS ON SMALL FIRMS

Exhibit VII-1 displays the costs and impacts of Option I compliance requirements on small firms. It shows that no small firms are forecasted to close and that while small firms make up almost 40 percent of the affected universe they account for less than 12 percent of the annual costs projected for this regulation. No small entities will experience annual compliance costs in excess of 2 percent of sales with the majority of plants below one percent. Annual cost of compliance for facilities with water flows less than 10,000 GPD range from $2,890 for monitoring of total toxic organics which affects all segments of the universe, to $15,523 for some indirect discharging captives. It can be concluded then, that small firms are not expected to experience significant economic impacts.

EXHIBIT VII-1
Costs and Impacts on Small Firms (less than 10,000 GPD)

	D.D Job Shops	I.D Job Shops	IPCB	D.D. Captives	I.D. Captives	Total
Total Universe	300	2,700	400	2,500	7,500	13,900
Affected Universe	46	418	400	900	2,700	4,464
Number of Small Entities Affected	30	250	210	342	912	1,744
Total Annual Cost (millions)	.02	.5	.3	.5	113.9	115.2
Total Small Entities Annual Cost (millions)	0.01	.3	.1	.3	12.5	13.2
Average Annual Cost for Small Firms	2,890	2,890	2,890	2,890	15,523	-
Plant Closures	0	0	0	0		
Population Cost Increase	0.02	0.02	0.03	0.01	1	0.02

VIII. NEW SOURCE PERFORMANCE STANDARDS/PRETREATMENT STANDARDS FOR NEW SOURCES

VIII. NEW SOURCE PERFORMANCE STANDARDS/PRETREATMENT STANDARDS FOR NEW SOURCES

The Federal Water Pollution Control Act of 1972 (the "Act") requires that New Source Performance Standards (NSPS) represent the best available demonstrated control technology, processes, and operating methods. Where practicable, no pollutant discharge at all is supposed to be allowed. Where pollutant discharge is unavoidable, these standards are to represent the greatest degree of effluent reduction achievable. NSPS applies only to direct dischargers.

Pretreatment Standards for New Sources (PSNS) will regulate indirect dischargers. The Act states that pretreatment standards shall prevent the discharge to a publicly-owned treatment works (POTW) of any pollutant that may interfere with, pass through, or otherwise be incompatible with the POTW. The amendments to the Act further stipulate that industrial discharges must not interfere with use and disposal of municipal sludges.

Both NSPS and PSNS apply specifically to new sources. New sources are defined as any building, structure, facility, or installation that discharges pollutants and for which construction is started after proposal of the relevant standards, but only if the standard is promulgated within 120 days of their proposal or after promulgation of the standard which are applicable to the source.

One option was selected for all new source standards. The NSPS/PSNS treatment system consists of the Option 1 end-of-pipe treatment system (described earlier in this report) plus in-plant controls for cadmium. In-plant controls could include evaporative recovery, ion exchange, and recovery rinses. The purpose of these in-plant controls is to reduce cadmium concentration levels in the raw waste stream.

Due to the nature of this option, only new sources that perform cadmium plating operations will incur additional compliance requirements beyond the proposed BPT/BAT/PSES standards. EPA estimates that 15 percent of existing sources plate with cadmium. It is likely, therefore, that the NSPS/PSNS requirements will concern only a small segment of the metal finishing population.

Information collected on the existing cadmium users indicates that they are generally larger and more diverse than non-cadmium users*, specifically:

- Job shop cadmium platers are generally much larger than job shops that do not plate with cadmium.
- Job shop cadmium platers use twice as many types of metals as non-cadmium platers.
- Indirect discharging captive cadmium platers consume twice as much water as either their direct discharging counterparts or the non-cadmium users.
- Direct discharging cadmium platers use less water than all other types of captives, but they generally employ more people and work with more metals.

The incremental cost to new sources of controlling cadmium was used as the basis for measuring these standards' competitive effects. Annual control costs were calculated for five different water flow categories. The Environmental Protection Agency supplied information on annual costs of cadmium control as a function of water use volume.** The costs were based on the following agency specifications:

- Use of evaporators capable of treating 20 G.P.H
- Cadmium flow accounting for 2.7 percent of total plant process flow
- Raw materials savings resulting from recovery of cadmium chloride and chromic acid, both byproducts of the pollution control process
- Annualization calculations based on 13 percent cost of capital, five year depreciation schedule, and ten year asset life.

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* This information is based on two memos. The first is dated March 5, 1981 and is from Mr. Jack Nash to Mr. Richard Kinch. The second is dated May 1, 1981 and is from Mr. Lior Samuelson to Mr. Art Berman.

** This information is contained in a December 3, 1982 memorandum from Mr. Richard Kinch to Ms. Kathy Ehrensberger.

The annual costs of cadmium control are shown in Exhibit VII-1.

EXHIBIT VIII-1
Incremental NSPS/PSNS Annual Cost By Metal Finishing Water Flow Category
(In $1982)

Flow G.P.D	Incremental Annual Costs of Option 3
0-10,000	$14,388
10,000-25,000	20,727
25,000-75,000	24,436
75,000-200,000	15,860
200,000-500,000	21,054
500,000+	17,550

The cost effects for five plant sales categories due to NSPS/PSNS requirements were calculated by the following three step process:

- For each plant sales category, model plants were clustered according to water flow.*
- Within each sales category, cost effects were calculated for each water flow cluster by dividing the incremental Option 3 compliance cost by plant sales. This approach is similar to the one used to measure economic impacts of Options 1 and 2 on the captive metal finishing population.
- A weighted average cost effect was calculated for each plant sales category based on the relative importance of the water flow clusters.

The results of these calculations are presented in Exhibits VIII-2 to VIII-7. The cost effects range from .02 percent for the largest plants to 2 percent for the smallest. In general, as plants' sales volumes grow larger, the cost effects become very small. In addition, the cost effects for nearly 90 percent of the plants (assuming that new sources have a size distribution equivalent to existing sources) are .75 percent or less.

Based on the available data, it does not seem that the additional costs to comply with the additional costs to

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* Source: 1976-77 Survey of Metal Finishers.

EXHIBIT VIII-2
NSPS/PSNS Average Cost Effects
(in 1982$)

Category Sales	Percent of Existing Plants in Sales Cateory	Average Cost Effects To Option 3 Costs
1mm	11.0%	2.0%
5mm	23.2	0.5
10mm	14.8	0.2
50mm	35.8	0.4
100mm	16.2	0.2

comply with the NPS/PSNS standards will erect significant entry barriers or create competitive disadvantages. The main reasons are the following:

- The incremental cost of compliance with Option 3 is small. (Between 0.02 percent and 2.0 percent of the value of sales).
- Only a small percentage of the metal finishing universe uses cadmium. Assuming that this trend holds for new source metal finishers, the vast majority of plants will have no compliance requirements at all due to NSPS/PSNS cadmium controls.
- In some processes, cadmium plating may be substituted for other metals. This will relieve these new sources of NSPS/PSNS cadmium controls. In cases where substitution is not possible due to the characteristics of cadmium, cost can be passed through as a result of inelastic demand.

In general, the decision of a firm to enter into the market for metal finishing will be insensitive to the incremental burden of NSPS/PSNS. For captives, metal finishing is an input into the production process. As such, they perform metal finishing in-house to ensure continuous supply, to minimize work flow disruptions, and to lower transportation and packaging costs. If the relative costs of NSPS/PSNS were high, captives could decide to obtain finishing services from existing job shops. New job shop sources will have the same effluent guideline requirements as existing sources unless the new plants use cadmium. The decision to use cadmium will be dictated by the demand for cadmium plating. Elastic demand will mean a high probability of no cadmium use while inelastic demand means little or no competitive impacts.

EXHIBIT VIII-3
NSPS/PSNS Cost Effects for Plants With Sales of $1 Million or Less
(in 1982$)

Percent of All Existing Plants	Metal Finishing Flow (GPD)	Percent of $1 Million Plants With This M.F. Flow	Incremental Annual/ Option 3 Cost	Percent Cost Effect
11%	0-10,000	67	$14,388	1.4
	10,000-25,000	15	20,727	2.1
	25,000-75,000	11	24,436	2.4
	75,000-200,000	5	15,860	1.6
	200,000-500,000	1	21,054	2.1
	500,000+	1	17,550	1.7

EXHIBIT VIII-4
NSPS/PSNS Cost Effects for Plants With Sales Between $1 Million and $5 Million
(in 1982$)

Percent of All Existing Plants	Metal Finishing Flow (GPD)	Percent of $5 Million Plants With This M.F. Flow	Incremental Annual/ Option 3 Cost	Percent Cost Effect
23.2%	0-10,000	58	$14,388	0.5
	10,000-25,000	15	20,727	0.7
	25,000-75,000	10	24,436	0.8
	75,000-200,000	5	15,860	0.5
	200,000-500,000	6	21,054	0.7
	500,000+	6	17,550	0.6

EXHIBIT VIII-5
NSPS/PSNS Cost Effects for Plants With Sales Between $5 Million and $10 Million
(in 1982$)

Percent of All Existing Plants	Metal Finishing Flow (GPD)	Percent of $10 Million Plants With This M.F. Flow	Incremental Annual/ Option 3 Cost	Percent Cost Effect
14.8%	0-10,000	32	$14,388	0.2
	10,000-25,000	20	20,727	0.2
	25,000-75,000	10	24,436	0.2
	75,000-200,000	16	15,860	0.2
	200,000-500,000	12	21,054	0.2
	500,000+	8	17,550	0.2

EXHIBIT VIII-6
NSPS/PSNS Cost Effects for Plants With Sales Between $10 Million and $50 Million
(in 1982$)

Percent of All Existing Plants	Metal Finishing Flow (GPD)	Percent of $50 Million Plants With This M.F. Flow	Incremental Annual/ Option 3 Cost	Percent Cost Effect
35.8%	0-10,000	25	$14,388	0.2
	10,000-25,000	15	20,727	0.4
	25,000-75,000	20	24,436	0.4
	75,000-200,000	15	15,860	0.2
	200,000-500,000	21	21,054	0.3
	500,000+	4	17,550	0.2

EXHIBIT VIII-7
NSPS/PSNS Cost Effects for Plants With Sales Greater than $100 Million
(in 1982$)

Percent of All Existing Plants	Metal Finishing Flow (GPD)	Percent of $100 Million Plants With This M.F. Flow	Incremental Annual/ Option 3 Cost	Percent Cost Effect
15.2%	0-10,000	13	$14,388	0.2
	10,000-25,000	7	20,727	0.2
	25,000-75,000	17	24,436	0.2
	75,000-200,000	16	15,860	0.1
	200,000-500,000	30	21,054	0.2
	500,000+	16	17,550	0.1

IX. LIMITS OF THE ANALYSIS

IX. LIMITS OF THE ANALYSIS

The purpose of this chapter is to summarize the issues that bear upon the "power" of the findings presented herein. The data and analytic constraints must be understood in order for the estimates of industry impacts to be held in perspective. Accordingly, the applicability of the results rests with how well the data, logic and assumptions of the models reflect reality.

The focus of this chapter are the major limitations involving study issues relating to the:

- Quality and quantity of the data
- Agency survey updates on equipment in place
- Type of models used
- Biases due to analysis assumptions.

1. QUALITY AND QUANTITY OF THE DATA

A major strategic consideration in the planning of this study was the appropriate source of information. Agency timing constraints regarding new financial and economic survey work necessitated the use of data from prior analyses. This decision could have a bearing on the findings of this study. The Economic Impact Analysis relies on data obtained in the 1976-77 Survey of Metal Finishers. The forecasted impacts may be sensitive to any change in the economic and/or financial characteristics of the Metal Finishing universe between 1976-77 and 1983; however, Appendix D suggests that changes are unlikely to be significant.

2. AGENCY SURVEYS ON EQUIPMENT IN PLACE

The Agency conducted two surveys of the Metal Finishing universe. The purpose of the surveys was to update information on the proportion of metal finishers that would require additional pollution control equipment in order to meet proposed BAT regulations. The survey of direct dischargers* was conducted on a sample derived from the NPDES permit records, while the surveys of indirect dischargers* relied on the technical contractor's data base. The projected magnitude of compliance costs and plant closures is sensitive to any changes in the results of the surveys due to sampling or data base biases. It is likely additional equipment has been installed since the survey; thus this analysis may overstate costs.

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* The survey's sample design and selection procedure is described in an August 20, 1981 memorandum from Mr. Richard Kotz to Mr. David Pepson. The results of the survey are contained in a memorandum from Mr. Henry D. Kahn to Mr. David Pepson.

3. TYPE OF MODELS USED

Two distinct models were used to analyze the economic impacts. In general, the design of the models was constrained by data availability. The job shop model is essentially a capital budgeting closure analysis that assumes full cost pass through. Different assumptions on the elasticity of demand, interest rates, and the model plants' financial condition may yield different results.

The model used to analyze the impacts on the captive sector assumes various critical price increase limits. Any plant projected to require a greater price increase is considered a candidate for closure. A change in the critical price limits would alter the results of the analysis. In addition, the captive analysis assumes a full cost pass through. A precise prediction of price and output changes due to the regulation is not possible due to the complexity of the Metal Finishing universe. The approach taken here therefore, limits somewhat the accuracy of the forecasts.

4. BIASES DUE TO ANALYSIS ASSUMPTIONS

In an effort not to understate compliance costs, the Agency made certain conservative assumptions which may have yielded higher compliance costs than are estimated in this report. Three examples are described below.

(1) Flow Reduction

A major variable which determines total costs is flow volume. In general, the larger a plant's flow volume, the larger its cost of compliance will be. Because plants will achieve compliance cost savings by reducing their wastewater flow volume, it is likely that this will happen. However, the Agency treated current flow volume as a constant, i.e., no flow reduction was assumed. The effect of this assumption is that compliance costs may be overstated.

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* Results of these surveys are described in a July 30, 1981 memorandum and a December 3, 1981 memorandum from Mr. Richard Kinch to Mr. Art Berman.

(2) Removal Credits

Indirect dischargers may be able to obtain pollutant removal credits from their POTW's. This means that the actual pollutant removal requirements for plants are reduced. As a result, a less costly form of pollution control will be possible in some cases. However, the Agency did not assume this when deriving its compliance cost estimates. It assumed that the existence of removal credits will not reduce compliance costs. As a result, compliance cost estimates may be overstated.

(3) Treatment of Non-Metal Finishing Process Wastestreams

A substantial number of metal finishing plants, particularly captives, have other process wastestreams in addition to those which are metal finishing.* All of a plant's wastestreams are typically treated by one end-of-pipe treatment system, though this may not always be the case. EPA assumed that a treatment system will be sized according to total process wastewater flow, rather than just metal finishing flow. The treatment system is assumed to treat all of a plant's wastewater flow. Thus, it is possible that treatment systems were sized and costed which are larger than necessary. This bias may result in an overstatement of estimated costs.

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* The costs of treating these streams are also considered when EPA promulgates other categorical standards. In essence, EPA has counted such costs twice, in separate rulemakings.

APPENDIX A

ANNUALIZATION OF INVESTMENT COST

APPENDIX A

ANNUALIZATION OF INVESTMENT COST

Operating and maintenance costs of a pollution control treatment system were estimated by the technical contractor as being 12 percent of total investment costs. This percentage of investment costs was added to a capital recovery factor to derive annual costs as a percentage of capital costs.

The capital recovery factor (CRF) measures the required rate of return on an investment in order to cover investment costs and maintain a firm's net earnings. The formula for CRF is:

$$CRF = \frac{A(N,K_f)\ (.9-x)}{1-t}$$

where: $$x = \sum_{1}^{n} \frac{td}{(1+K_f)^n}$$

N = physical life of investment
K_f = average after-tax cost of capital
$A(N,K_f)$ = annuity whose present value if 1, given N and K_f $[K_f/(1-(1+K_f)^{-n})]$
t = marginal corporate tax rate
d = annual depreciation rate
n = depreciation lifetime

The values used in this calculation are:

- Physical life of investment: 10 years
- Average after-tax cost of capital: 13 percent
- Marginal corporate tax rate: 48 percent
- Annual depreciation rate: 20 percent
- Depreciation lifetime: 5 years

These values were assumed for the following reasons:

- The Survey shows that 10 years is an appropriate estimate for a treatment system's physical life
- The after-tax cost of capital was derived using assumptions based on current economic conditions. These assumptions include:
    - A typical firm's capital structure of 25 percent debt and 75 percent equity

- Nominal cost of debt = 12 percent

  - .. The cost of debt was based on quotations from the New York Bond Exchange (June 17, 1983) which showed that the average bond rate was approximately 12 percent.

- Nominal cost of equity = 15 percent

  - .. Cost of equity is determined based on shareholders' expectations. Yields on competing securities is the major input into the or determination of the cost of equity. Equity constitutes a riskier investment than debt and its cost is normally higher. Firms do not publish their cost of equity--most companies can only estimate the cost of equity ex-post. The cost of equity was assumed to be 15 percent in this analysis since the cost of equity is usually one to five points higher than the cost of debt.

The 13 percent cost of capital estimate is based on the cost of debt and equity stated above and represents an overall industry average calculated for the purposes of this analysis. A given firm's cost of capital may vary somewhat from this estimate, based on its relative financial position, performance, capital structure, credit rating, size, and overall economic environment in which it operates.

- Corporate taxes are based on a graduated schedule--20 percent on the first $25,000 in profits; 22 percent on the next $25,000; and 46 percent for all profits above $50,000. Most profitable firms will therefore pay taxes at 46 percent on the margin, but slightly less than that on the average. Less profitable firms will pay 20 percent or 22 percent in taxes, while unprofitable firms pay nothing. To account for these differentials, a marginal rate of 44 percent, slightly less than the rate, which most firms pay, was assumed. Also, state corporate income taxes (deductible from federal taxes) may be as high as 9.5 percent, and average slightly less.[1] An 8 percent rate is assumed here, or an effective rate of about 4 percent. Thus, the total tax rate assumed for this analysis is 48 percent.

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[1] Economic Impact Analysis for Proposed Effluent Limitations and Standards for the Organic Chemicals, Plastics and Synthetic Fibers Industry, United States Environmental Protection Agency, March, 1983, p. 2A-4.

- Changes in the tax code over the last two years not allow firms to depreciate capital investments over a 5 year period. A depreciation rate of 20 percent was therefore assumed.

Finally, note that the CRF formula accounts for a investment tax credit of 10 percent, reflecting another farily recent change in the tax code.

When all these numbers are plugged into the CRF formula, a value of 21 percent is derived. To determine the annualization rate for pollution control investment costs, this value is added to the operating and maintenance costs which comprise 12 percent of investment costs. This yields a value of 33 percent. For example, plant number 2036 in Exhibit B-6 is projected to invest $234,143. Using this annualization methodology yields a value of $77,267 as the annual cost.

APPENDIX B

JOB SHOP AND IPCB ANALYSIS

APPENDIX B

JOB SHOP AND IPCB ANALYSIS

This Appendix presents a detailed description of the job shop and IPCB impact methodology and the inputs associated with it.

1. THE CLOSURE MODEL

The model operates in the same manner for both job shops and IPCBs. There are two primary operations of the closure model: the first operation involves assigning and costing pollution control equipment for each model plant, and the second operation involves factoring this incremental cost into the financial condition of each case to predict firms likely to close. Each operation is described below.

(1) Assigning and Costing Pollution Control Equipment

Operationally the routine can assign any or all of the following treatment cost components:

- Chrome reduction
- Cyanide oxidation
- pH adjustment
- Clarifier/filter
- Line segregation

The following decision rules took into account the following specific components of each firm. A firm received:

- Chrome reduction if:
    - Chrome was present
    - Chromating or anodizing was present
- Cyanide oxidation if:
    - Cadmium was present
    - Copper, zinc, tin or precious metals were present
- pH adjustment was assigned:
    - For all plants

- Clarifiers or filters were assigned if:
  - Trace metals were present
  - Metals removal was required by the regulation
  - Filters were prescribed for interior space-constrained firms
  - Clarifiers for all other plants

In addition to specifying the pollution control components, the routine applies a cost factor to each. Components are costed as a function of two factors:

- The proportion of the total plant flow through the component
- The unit cost of the component as a cost equation (dollars x GPH)

Different types of finishing operations have characteristic flow levels for their pollution control equipment. Metal finishing process water flow was allocated to the various waste treatment components according to the following assumptions made by the technical contractor:

- Plants requiring installation of cyanide destruction and pH equipment have about 56 percent of their metal finishing water flowing to the cyanide destruction unit.
- Plants requiring installation of hexavalent chromium reduction and pH adjustment equipment have about 23 percent of their metal finishing water flowing to the chrome reduction unit.
- Plants requiring installation of systems fall into two categories:
  - Plants which perform more than six operations have about 62 percent of their metal finishing water flow to the cyanide destruction unit and about 4 percent of their metal finishing water flowing to the hexavalent chromium reduction unit.

- Plants with six or fewer operations have about 8 percent of their metal finishing water flow to the cyanide destruction unit and about 10 percent flowing to the hexavalent chromium reduction unit.

- In all cases, all the metal finishing water flows through the pH adjustment unit.

2. Variable Definitions

The cost program (PPC) is in Fortran. The total capital costs for a plant are the summation of all treatment components plus line segregation cost, adjusted by a credit for needed equipment already in place. The key variables are identified and the flow logic of the model (Exhibit B-1) is presented below:

(1) IA -- Indicates whether the firm needs equipment type I.

Position 1 - chrome equipment
2 - cyanide total option equipment
3 - cyanide amenable option equipment
4 - batch process operation clarifier
5 - continuous process operation clarifier
6 - filter
7 - pH adjustment equipment

(2) IB -- Shows that the firm had used some metals but that those metals do not require a particular type of treatment.

(3) RIC -- Stores the percentage of credit given for considering equipments already in place.

(4) ICROP -- Pointers to processes anodizing and chromating for checking purposes.

(5) IOP -- Type of operation performed by the firm:

1) Anodizing
2) Coloring
3) Phosphating
4) Chromating
5) Electrolysis on plastics
6) Electrolysis on metals
7) Chemical milling
8) Non-aqueous plating
9) Bright dip
10) Chemical etching
11) Electrochemical milling

(6) IMETal -- Indicates which metals did the firms use:

- Plants with six or fewer operations have about 8 percent of their metal finishing water flow to the cyanide destruction unit and about 10 percent flowing to the hexavalent chromium reduction unit.

- In all cases, all the metal finishing water flows through the pH adjustment unit.

2. Variable Definitions

The cost program (PPC) is in Fortran. The total capital costs for a plant are the summation of all treatment components plus line segregation cost, adjusted by a credit for needed equipment already in place. The key variables are identified and the flow logic of the model (Exhibit B-1) is presented below:

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3) Phosphating
4) Chromating
5) Electrolysis on plastics
6) Electrolysis on metals
7) Chemical milling
8) Non-aqueous plating
9) Bright dip
10) Chemical etching
11) Electrochemical milling

(6) IMETal -- Indicates which metals did the firms use:

1) Copper
2) Nickel
3) Chromium
4) Cadmium
5) Zinc
6) Solder
7) Lead
8) Tin
9) Gold
10) Silver
11) Platinum
12) Iron
13) Brass
14) Bronze

1 for in use, 0 for not used

(7) Credit -- Percentage of credit selected to be applied to equipments in place, in 0 #% 1.

1) for chrome treatment
2) for cyanide treatment
3) for clarifier
4) filter
5) pH adjustment

(8) ICN -- Stores pointers to metals which require cyanide treatment.

(9) IPHD -- Indicators of whether a metal needs pH adjustment.

1 for yes, 0 for no.

Positions are the same as IMETal array.

(10) ICLFL -- Indicates which of the fourteen metals need a clarifier/filter.

1 for yes, 0 for no.

Positions are the same as IMETal array.

(11) IMPLac -- Indicates whether the firm already owns the equipment or has the treatment in place.

1 for yes, 0 for no.

1) chrome equipment/treatment
2) cyanide treatment
3) clarifier
4) filter
5) pH adjustment

(12) OMM -- Percentage factor for calculating operating and maintenance cost for pollution control.

(13) CTOTal -- Total capital cost for pollution control.

(14) IGOOD -- Number of complete data firms.

(15) INODO -- Number of incomplete data firms.

(16) Select -- Choice for selecting one single cost component.

1 for yes, 0 for no.

(17) HILO -- 2 for selecting the highest cost.
1 for selecting the lowest cost.

(18) PCentl -- Percentage factor for adjusting capital cost increase/decrease.

(19) COMC -- Operating and maintenance cost for pollution control.

(20) TType -- Type of firm.

1 - job shops
2 - printed boards

(21) Rxcost -- Cost of treatment already in place for captives.

(22) ICRCUT -- Cutoff level for chrome.

(23) ICNCUT -- Cutoff level for cyanide.

(24) ICLCUT -- Cutoff level for clarifier.

(25) IFLCUT -- Cutoff level for filter.

(26) IPHHI -- Cutoff level for pH adjustment, upper limit.

(27) IPHLO -- Cutoff level for pH adjustment, lower limit.

(28) Within high-low range, it is required.

(29) ICNOPT -- Cyanide option total.

(30) INOUT -- Area expansion indicator for clarifier/filter consideration.

interior expansion
exterior expansion

(31) Low -- Lowest cost component.

(32) High -- Highest cost component.

(33) IHRS -- Number of hours in operation per day.

(34) IPFLOW -- Water flow level in gpH unit.

(35) ICLQ -- Value separating, by water flow level, batch/continuous operation.

(36) ID -- Identification number for the firm.

(37) IPFLOW -- Water flow level in gpH unit.

(38) ICN2 -- Cost component adjustment for cyanide

1 for total, 0 for amenable.

(39) ICN2FL -- Cost component adjustment according to flow.

1 for total, 0 for amenable.

3. FINANCIAL CLOSURE MODEL

The closure routine identifies firms that are projected to close because of either:

- Limited capital access, or
- Insufficient profits.

Determinations of which firms would close are based on projections of what the firm's financial standing would be one year after the pollution control investments were made. The basic premise is that those future conditions would be evaluated by:

- A banker to determine if he would lend the firm sufficient funds for the investment, or by

- The owner(s) to determine if sufficient profits are projected to make it worthwhile for him (them) to remain in business, or whether the state of the business warrants an investment of further funds -- called an equity infusion -- into the firm in order to secure a bank loan.

These closure determinations are predicted by the closure model based on pro forma balance and income statement forecasts and quantitative decision rules. For job shops the balance and income statement were derived from the 1976-77 Survey of Metal Finishers. For IPCBs the financial information on 100 model plants was obtained from Dun and Bradstreet. As such, owner compensation information was not available and the closure determination was made without the use of equity infusion. The costs for the electroplating baseline were generated by the model and are assumed to be the same as those generated for the 1979 Electroplating Economic Impact Report. All other costs were estimated by the Environmental Protection Agency and were inputed to the model. These costs are described in the next section. The flow chart shown in Exhibit B-2 presents an overview of the sequential logical steps of the model.

4. COSTS OF COMPLIANCE

The costing rules for direct discharging job shops and IPCBs differed somewhat from those applied to indirect discharging job shops. The cost inputs are described below.

(1) Direct Discharging Job Shops

Agency surveys determined that the direct discharging job shop segment of the metal finishing universe has all the necessary equipment in place to meet Option I compliance levels. The only additional cost that would be incurred by this segment relate to monitoring of total toxic organics. As discussed in Chapter V, EPA Effluent Guidelines Division made the assumption that 15.5 percent or 56 job shops will have to baseline monitor, and 2.8 percent or 10 job shops will have to monitor for compliance. Exhibit B-3 shows the monitoring costs associated with TTO. All direct discharging job shops would have to invest in order to meet Option II compliance requirements. Exhibit B-4 shows all 28 direct discharging model plants and their associated Option II costs.

(2) Indirect Discharging Job Shops

All indirect discharging job shops were regulated by the 1979 electroplating pretreatment regulation, therefore, the only additional investments that they will have to make is in monitoring of total toxic organics and solvent disposal. Exhibit B-3 displays the costs of total toxic organics in those cases where it will be necessary. Solvent disposal will ordinarily impose no costs; however EPA has performed a sensitivity analysis of the impact of any such costs. The effects are summarized in Appendix F.

(3) Independent Printed Circuit Board Manufacturers (IPCB)

The independent printed circuit board industry was regulated by the electroplating pretreatment regulation. Under the metal finishing regulation, this segment could have to monitor for total toxic organics. It is assumed that there are 371 IPCB manufacturers that will be affected by this regulation. A total of 327 are indirect dischargers and 44 are direct dischargers.

This analysis assumes that all 371 IPCBS will baseline monitor, at a cost of $1904 each. It also assumes that 27 percent or 108 will have to monitor for compliance at an annual cost of $2890 per plant. Exhibit B-3 shows the monitoring costs associated with TTO.

5. APPLICATION OF COSTS AND SAMPLE CLOSURE

Under Option I of this regulation, job shops will only have to incur cost of monitoring for toxic organics. Monitoring has two components, the first is baseline monitoring which occurs once, and the second is compliance monitoring which occurs quarterly. The compliance date for TTO at job shops and IPCB's is 1986. Therefore, it was assumed that most plants will baseline monitor before 1986. In other words, expenditure for baseline and compliance monitoring will not occur in the same year.

Exhibit B-5 shows a direct discharging plant (number 42) that was projected to close under Option II compliance requirements. It displays the present financial condition of the firm and the projected condition after investment in pollution control. The capital costs for the firm were generated by the routine and are estimated to be $288,000. The plant will borrow 89.5 percent of that amount. Before investment the firm's coverage ratio is shown to be 77.7, considerably above the cut-off point of 1.5. After the investment the coverage ratio drops to 1.3, below the cut-off. This plant is projected to close, even with an equity infusion of more than $30,000. The displayed closure category of 1 means a closure, category 4 is an equity infusion save, and 2 means that the plant will survive.

6. EFFECTS ON RETURN ON INVESTMENT

The job shop segment of the universe was analyzed for investment impacts due to meeting Option I TTO requirements. This applies to both direct and indirect dischargers. Because detailed financial information is available for job shops, the effects of regulatory compliance on the industry's average return on investment (ROI) can be gauged.

The economic impact analysis presents the following financial data for 28 representative model plant job shops:

- Average sales: $1,111,000
- Average Net Income: $5,000
  - Average net income for 21 profitable plants: $65,000
  - Average net income for 7 unprofitable plants: -$209,000
- Average Assets: $603,000.

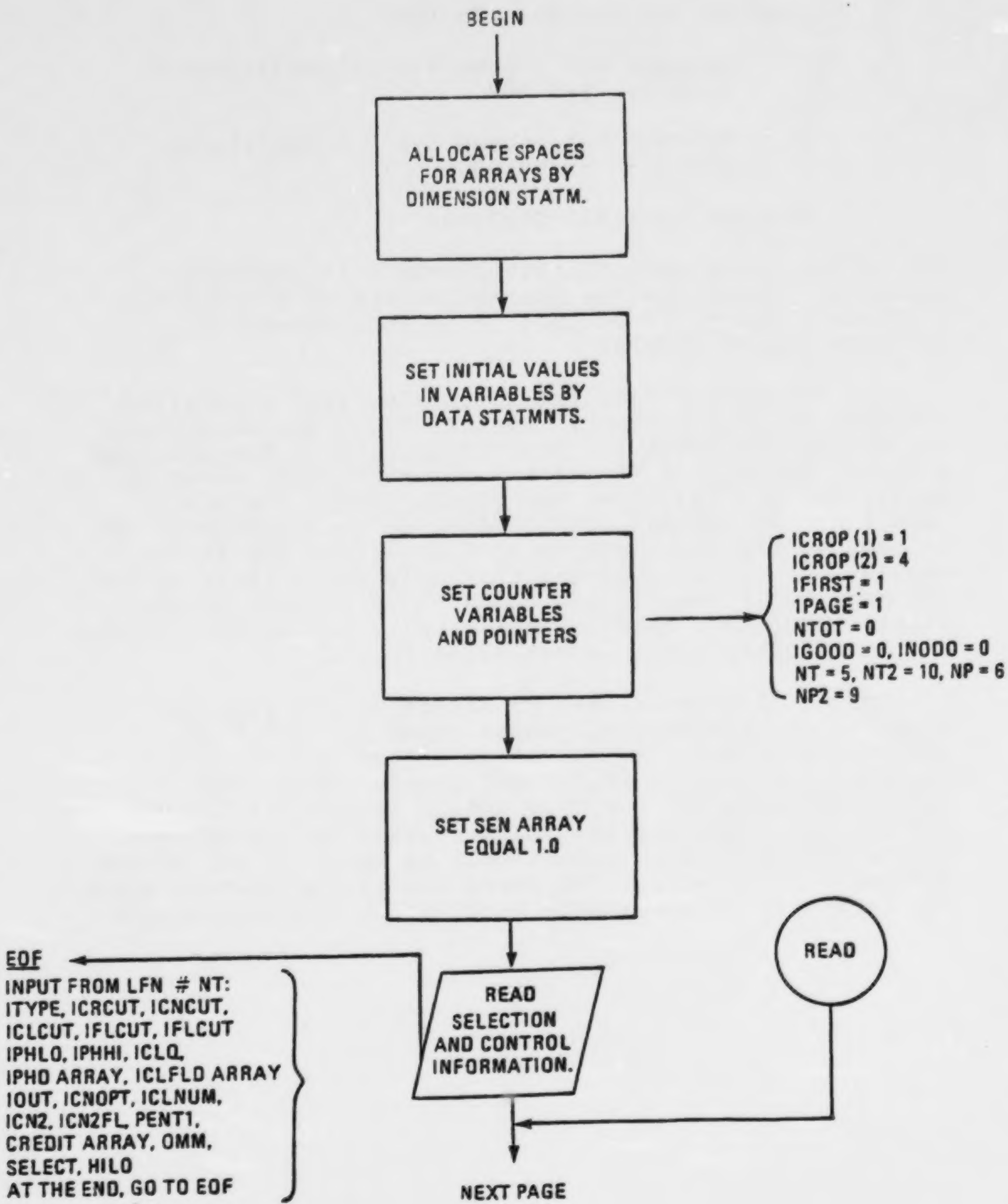
Six of the seven unprofitable plants were baseline closures. Thus, the average net income of $65,000 for profitable plants is assumed to be an indicator of industry income levels.

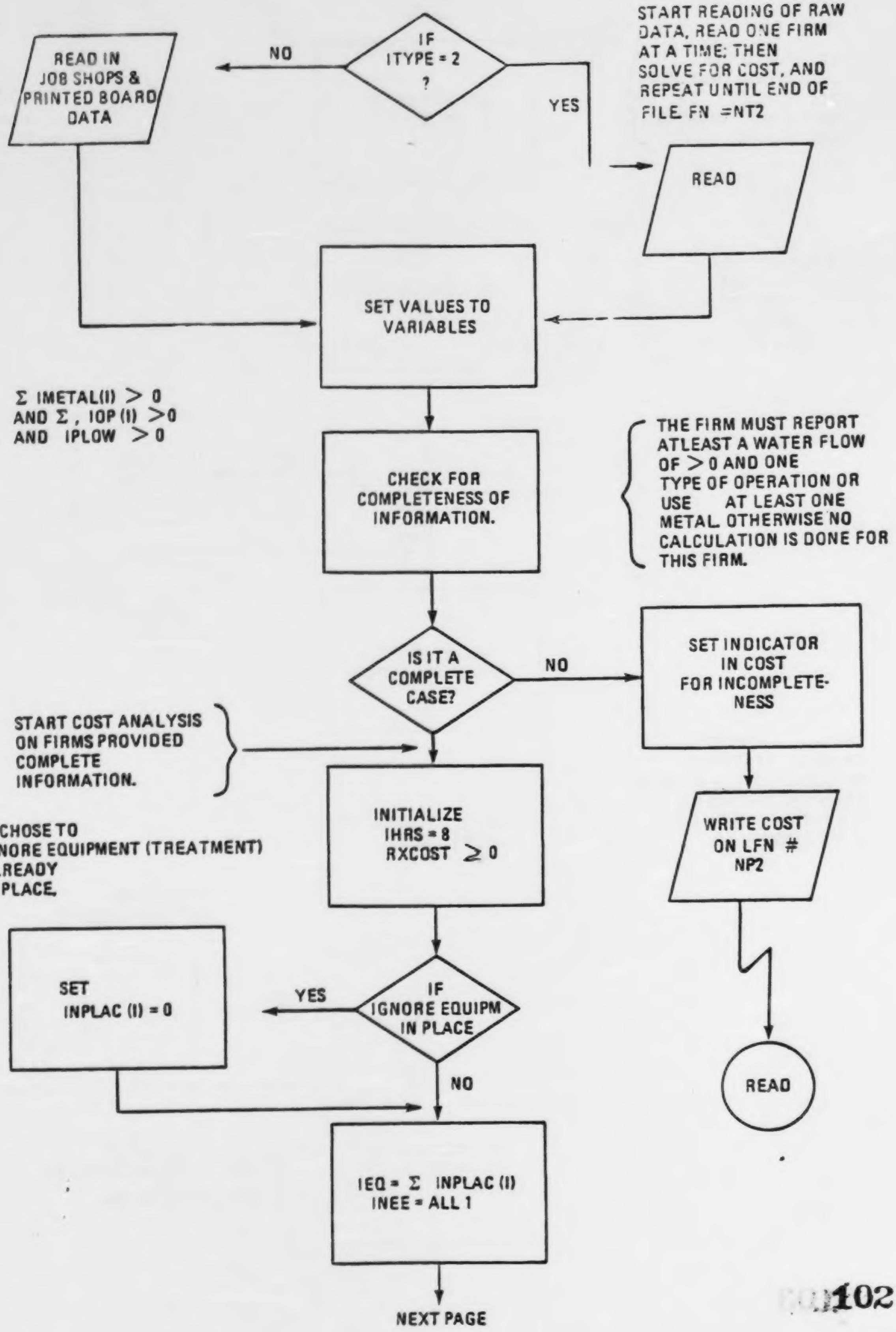
The industry's baseline ROI, calculated as $64,000/603,000, is 10.8 percent. Average TTO compliance costs are $2,890 per plant for the 2.8 percent of the affected plants. Assuming a 35 percent tax rate, this works out to be $1,878 in actual cost per plant. Thus, the post-compliance ROI is $62,122/603,000, or 10.3 percent. ROI is reduced for these plants by 0.5 percent due to the regulation. Note, however, that only 2.8 percent of the job shops will incur these costs; 97.2 percent of the plants incur zero costs. As a result, the overall effect on the industry's ROI is not significant.

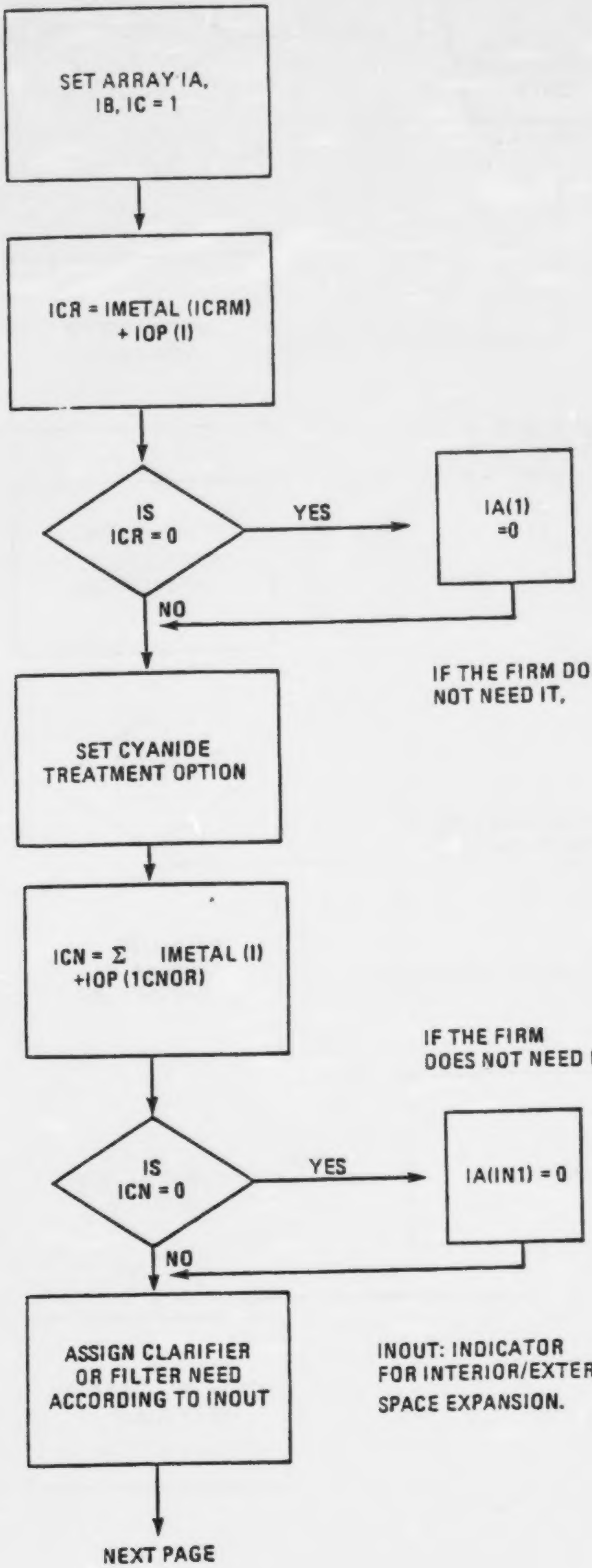
Option II relates only to direct discharging job shops. For this option, annual costs per plant are approximately $13,425. On an after-tax basis, this represents a cost of $8,725 per plant. Thus, the post-compliance ROI for this option is $55,275/603,000, or 9.2 percent. The average ROI decreases by 1.6 percent. Unlike Option I, this effect will be borne by all direct discharging job shops, for there are virtually none which are currently in compliance with Option II requirements.

EXHIBIT B-1

PROGRAM FLOWCHART


BEGIN
ALLOCATE SPACES FOR ARRAYS BY DIMENSION STATM.
SET INITIAL VALUES IN VARIABLES BY DATA STATMNTS.
SET COUNTER VARIABLES AND POINTERS
ICROP (1) = 1
ICROP (2) = 4
IFIRST = 1
1PAGE = 1
NTOT = 0
IGOOD = 0, INODO = 0
NT = 5, NT2 = 10, NP = 6
NP2 = 9
SET SEN ARRAY EQUAL 1.0
EOF
INPUT FROM LFN # NT:
ITYPE, ICRCUT, ICNCUT,
ICLCUT, IFLCUT, IFLCUT
IPHLO, IPHHI, ICLQ,
IPHD ARRAY, ICLFLD ARRAY
IOUT, ICNOPT, ICLNUM,
ICN2, ICN2FL, PENT1,
CREDIT ARRAY, OMM,
SELECT, HILO
AT THE END, GO TO EOF
READ SELECTION AND CONTROL INFORMATION.
READ
NEXT PAGE


START READING OF RAW DATA, READ ONE FIRM AT A TIME; THEN SOLVE FOR COST, AND REPEAT UNTIL END OF FILE. FN =NT2
READ IN JOB SHOPS & PRINTED BOARD DATA
NO
IF ITYPE = 2 ?
YES
READ
SET VALUES TO VARIABLES
Σ IMETAL(I) > 0 AND Σ, IOP (I) >0 AND IPLOW > 0
CHECK FOR COMPLETENESS OF INFORMATION.
THE FIRM MUST REPORT ATLEAST A WATER FLOW OF > 0 AND ONE TYPE OF OPERATION OR USE AT LEAST ONE METAL. OTHERWISE NO CALCULATION IS DONE FOR THIS FIRM.
IS IT A COMPLETE CASE?
NO
SET INDICATOR IN COST FOR INCOMPLETENESS
START COST ANALYSIS ON FIRMS PROVIDED COMPLETE INFORMATION.
INITIALIZE IHRS = 8 RXCOST ≥ 0
WRITE COST ON LFN # NP2
IF CHOSE TO IGNORE EQUIPMENT (TREATMENT) ALREADY IN PLACE.
SET INPLAC (I) = 0
YES
IF IGNORE EQUIPM IN PLACE
NO
READ
IEQ = Σ INPLAC (I) INEE = ALL 1
NEXT PAGE


SET ARRAY IA, IB, IC = 1
ICR = IMETAL (ICRM) + IOP (I)
IS ICR = 0
YES
IA(1) =0
NO
SET CYANIDE TREATMENT OPTION
ICN = Σ IMETAL (I) +IOP (1CNOR)
IS ICN = 0
YES
IA(IN1) = 0
NO
ASSIGN CLARIFIER OR FILTER NEED ACCORDING TO INOUT
NEXT PAGE

START WITH THE ASSUMPTION THAT ALL TYPES OF POLLUTION CONTROLS ARE NEEDED.

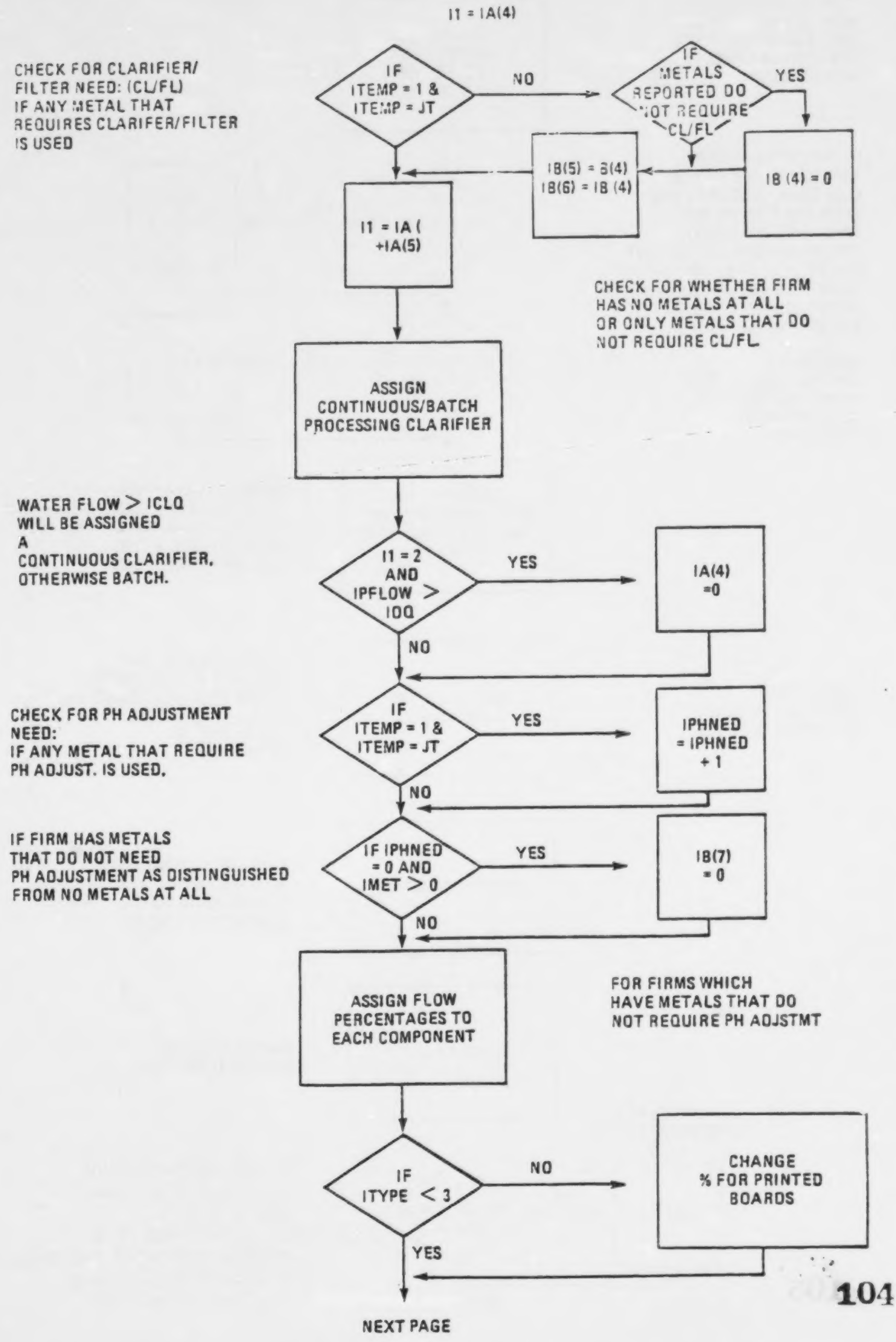
CHECK FOR NEED OF CHROME TREATMENT: EITHER ANODIZING/CHROMATING IS PERFORMED OR CHROMIUM IS PRESENT.

IF THE FIRM DOES NOT NEED IT.

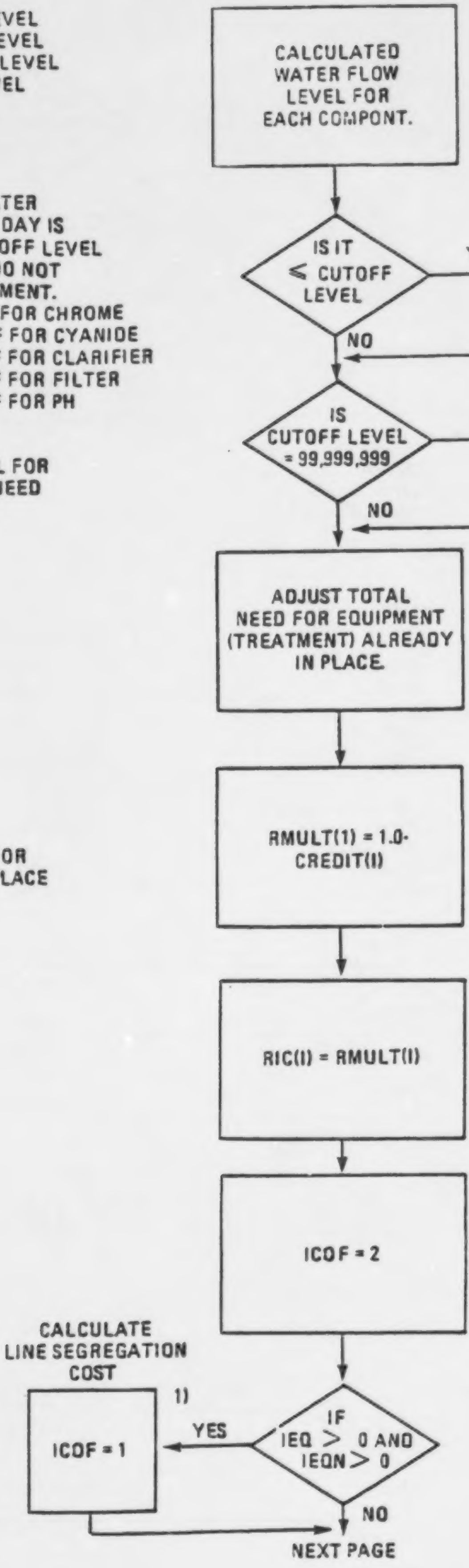
CHECK FOR NEED OF CYANIDE TREATMENT: PRESENCE (USE) OF CYANIDE CATEGORY METALS OR OPERATION BRIGHT DIP IS PERFORMED.

IF THE FIRM DOES NOT NEED IT.

INOUT: INDICATOR FOR INTERIOR/EXTERIOR SPACE EXPANSION.


I1 = IA(4)
CHECK FOR CLARIFIER/ FILTER NEED: (CL/FL) IF ANY METAL THAT REQUIRES CLARIFER/FILTER IS USED
IF ITEMP = 1 & ITEMP = JT
NO
IF METALS REPORTED DO NOT REQUIRE CL/FL
YES
IB(5) = B(4) IB(6) = IB (4)
IB (4) = 0
I1 = IA (+IA(5)
CHECK FOR WHETHER FIRM HAS NO METALS AT ALL OR ONLY METALS THAT DO NOT REQUIRE CL/FL
ASSIGN CONTINUOUS/BATCH PROCESSING CLARIFIER
WATER FLOW > ICLQ WILL BE ASSIGNED A CONTINUOUS CLARIFIER, OTHERWISE BATCH.
I1 = 2 AND IPFLOW > IOQ
YES
IA(4) =0
NO
CHECK FOR PH ADJUSTMENT NEED: IF ANY METAL THAT REQUIRE PH ADJUST. IS USED.
IF ITEMP = 1 & ITEMP = JT
YES
IPHNED = IPHNED + 1
NO
IF FIRM HAS METALS THAT DO NOT NEED PH ADJUSTMENT AS DISTINGUISHED FROM NO METALS AT ALL
IF IPHNED = 0 AND IMET > 0
YES
IB(7) = 0
NO
ASSIGN FLOW PERCENTAGES TO EACH COMPONENT
FOR FIRMS WHICH HAVE METALS THAT DO NOT REQUIRE PH ADJSTMT
IF ITYPE < 3
NO
CHANGE % FOR PRINTED BOARDS
YES
NEXT PAGE

QCR - CHROME LEVEL
QCN - CYANIDE LEVEL
QCL - CLARIFIER LEVEL
QFL - FILTER LEVEL
QPH - PH LEVEL


CALCULATED WATER FLOW LEVEL FOR EACH COMPONT.
IS IT ≤ CUTOFF LEVEL
YES
SET IA(I) = 0
NO
IS CUTOFF LEVEL = 99,999,999
YES
SET IA = 0
NO
ADJUST TOTAL NEED FOR EQUIPMENT (TREATMENT) ALREADY IN PLACE
RMULT(1) = 1.0-CREDIT(I)
RIC(I) = RMULT(I)
ICOF = 2
IF IEQ > 0 AND IEQN > 0
YES
1)
CALCULATE LINE SEGREGATION COST
ICOF = 1
NO
NEXT PAGE

IF THE TOTAL WATER GENERATED PER DAY IS LESS THAN = CUTOFF LEVEL THEN THE FIRM DO NOT NEED THE TREATMENT.
ICRCUT: CUTOFF FOR CHROME
ICNCUT : CUT OFF FOR CYANIDE
ICLCUT : CUT OFF FOR CLARIFIER
ICLCUT : CUT OFF FOR FILTER
IPHCUT : CUT OFF FOR PH

99999999 IS A CONTROL SIGNAL FOR REMOVING THE NEED REGARDLESS OF ANYTHING

INEED(1) = IA(1) + IB(1)
INEED(2) = IA(2) + IB(2) + IA(3) + IB(3)
INEED(3) = IA(4) + IB(4) + IA(5) IB(5)
INEED(4) = IA(6) + IB(6)
INEED(5) = IA(7) + IB(7)

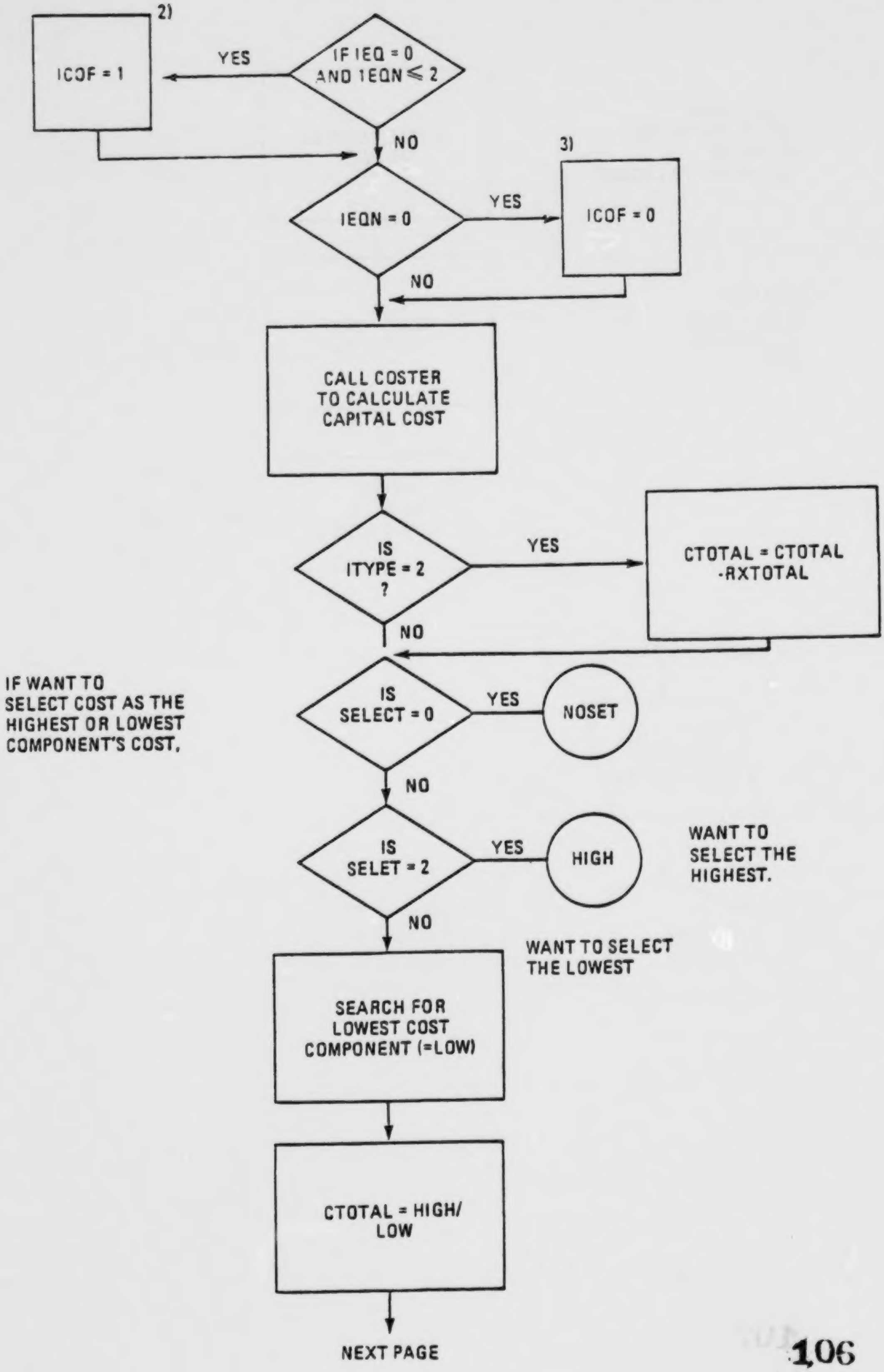
• ADJUST FOR CREDIT GIVEN FOR EQUIPMENT IN PLACE

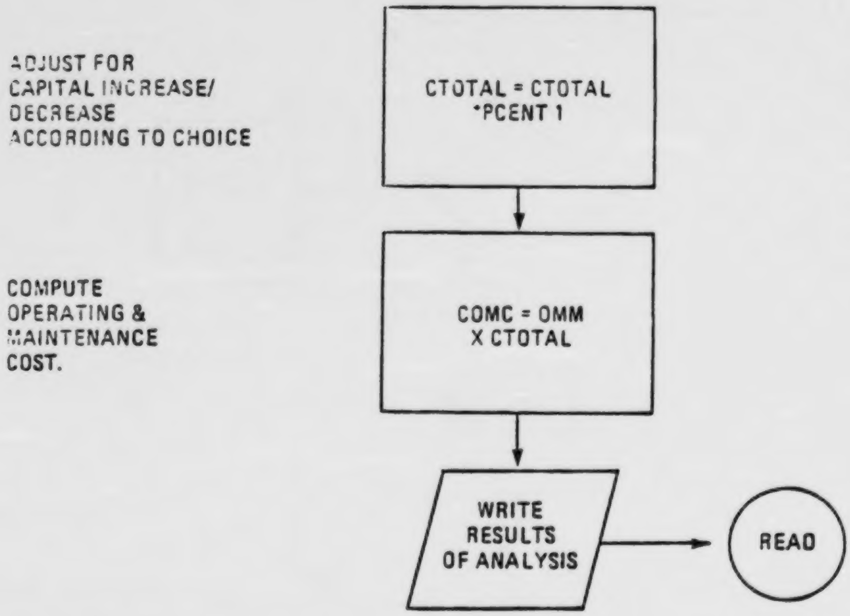
IF CHOOSING TO GIVE CREDIT FOR TREATMENT ALREADY IN PLACE AND ONLY IF THE FIRM NEEDS THAT TYPE OF TREATMENT.

PLACE RMULT VALUES INTO RIC FOR TRANSFERING TO SUBROUTINE COSTER.

INITIALYZE LINE SEGREGATION COST.

1) IF THE FIRM NEEDS EQUIP AND HAS EQUIP IN PLACE, COST IS HALF.
2) IF THE FIRM NEED ≤ 2 PIECES OF EQUIPMENT, COST IS HALF
3) IF NO EQUIP IN PLACE, NEED > 2, ASSIGN FULL COST


2)
ICOF = 1
YES
IF IEQ = 0
AND IEQN ≤ 2
NO
3)
IEQN = 0
YES
ICOF = 0
NO
CALL COSTER
TO CALCULATE
CAPITAL COST
IS
ITYPE = 2
?
YES
CTOTAL = CTOTAL
-RXTOTAL
NO
IF WANT TO
SELECT COST AS THE
HIGHEST OR LOWEST
COMPONENT'S COST,
IS
SELECT = 0
YES
NOSET
NO
IS
SELET = 2
YES
HIGH
WANT TO
SELECT THE
HIGHEST.
NO
WANT TO SELECT
THE LOWEST
SEARCH FOR
LOWEST COST
COMPONENT (=LOW)
CTOTAL = HIGH/
LOW
NEXT PAGE


ADJUST FOR CAPITAL INCREASE/ DECREASE ACCORDING TO CHOICE
CTOTAL = CTOTAL *PCENT 1
COMPUTE OPERATING & MAINTENANCE COST.
COMC = OMM X CTOTAL
WRITE RESULTS OF ANALYSIS
READ

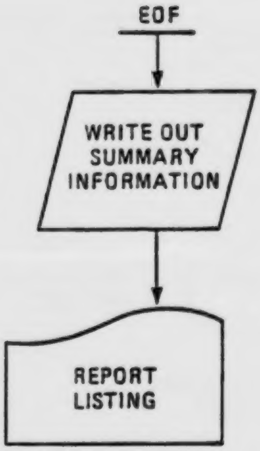
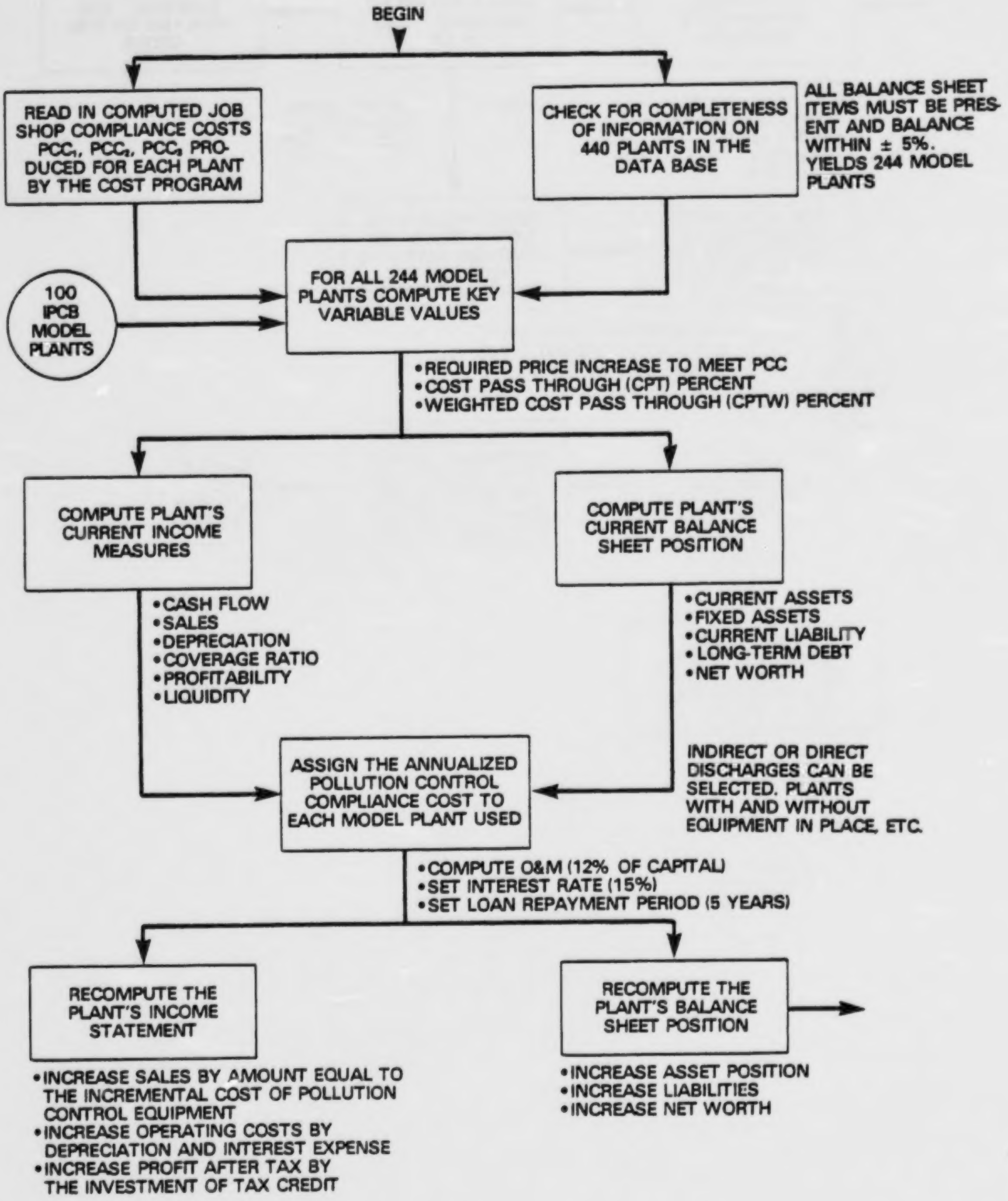

EOF
WRITE OUT SUMMARY INFORMATION
REPORT LISTING

EXHIBIT B-2

BOOZ•ALLEN AUTOMATED FINANCIAL CLOSURE MODEL


BEGIN
READ IN COMPUTED JOB SHOP COMPLIANCE COSTS PCC_1, PCC_2, PCC_3 PRODUCED FOR EACH PLANT BY THE COST PROGRAM
CHECK FOR COMPLETENESS OF INFORMATION ON 440 PLANTS IN THE DATA BASE
ALL BALANCE SHEET ITEMS MUST BE PRESENT AND BALANCE WITHIN ± 5%. YIELDS 244 MODEL PLANTS
100 IPCB MODEL PLANTS
FOR ALL 244 MODEL PLANTS COMPUTE KEY VARIABLE VALUES
•REQUIRED PRICE INCREASE TO MEET PCC
•COST PASS THROUGH (CPT) PERCENT
•WEIGHTED COST PASS THROUGH (CPTW) PERCENT
COMPUTE PLANT'S CURRENT INCOME MEASURES
•CASH FLOW
•SALES
•DEPRECIATION
•COVERAGE RATIO
•PROFITABILITY
•LIQUIDITY
COMPUTE PLANT'S CURRENT BALANCE SHEET POSITION
•CURRENT ASSETS
•FIXED ASSETS
•CURRENT LIABILITY
•LONG-TERM DEBT
•NET WORTH
ASSIGN THE ANNUALIZED POLLUTION CONTROL COMPLIANCE COST TO EACH MODEL PLANT USED
INDIRECT OR DIRECT DISCHARGES CAN BE SELECTED. PLANTS WITH AND WITHOUT EQUIPMENT IN PLACE, ETC.
•COMPUTE O&M (12% OF CAPITAL)
•SET INTEREST RATE (15%)
•SET LOAN REPAYMENT PERIOD (5 YEARS)
RECOMPUTE THE PLANT'S INCOME STATEMENT
RECOMPUTE THE PLANT'S BALANCE SHEET POSITION
•INCREASE SALES BY AMOUNT EQUAL TO THE INCREMENTAL COST OF POLLUTION CONTROL EQUIPMENT
•INCREASE OPERATING COSTS BY DEPRECIATION AND INTEREST EXPENSE
•INCREASE PROFIT AFTER TAX BY THE INVESTMENT OF TAX CREDIT
•INCREASE ASSET POSITION
•INCREASE LIABILITIES
•INCREASE NET WORTH

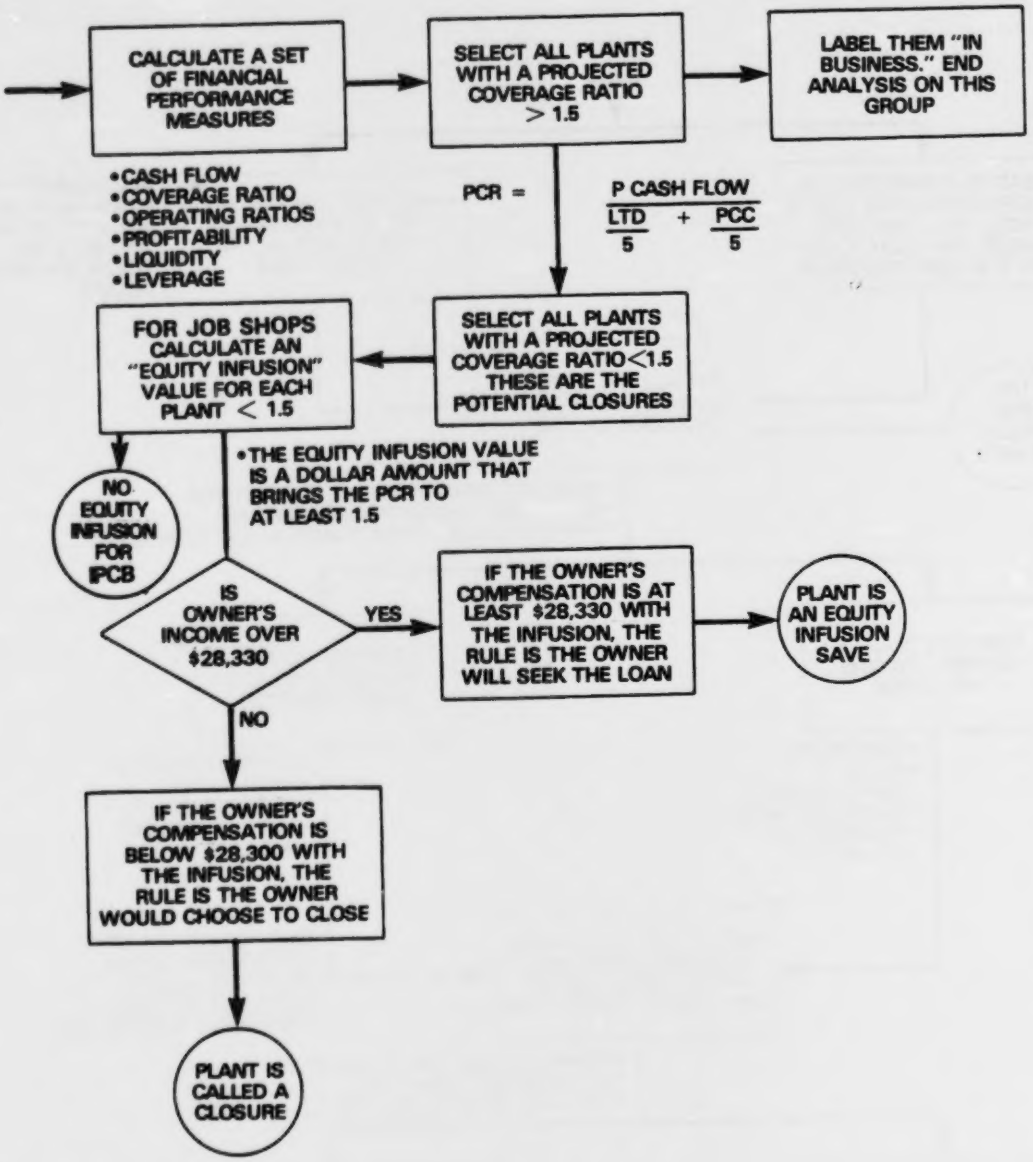

CALCULATE A SET OF FINANCIAL PERFORMANCE MEASURES
•CASH FLOW
•COVERAGE RATIO
•OPERATING RATIOS
•PROFITABILITY
•LIQUIDITY
•LEVERAGE
SELECT ALL PLANTS WITH A PROJECTED COVERAGE RATIO > 1.5
LABEL THEM "IN BUSINESS." END ANALYSIS ON THIS GROUP
PCR = P CASH FLOW / (LTD/5 + PCC/5)
SELECT ALL PLANTS WITH A PROJECTED COVERAGE RATIO<1.5 THESE ARE THE POTENTIAL CLOSURES
FOR JOB SHOPS CALCULATE AN "EQUITY INFUSION" VALUE FOR EACH PLANT < 1.5
NO EQUITY INFUSION FOR IPCB
•THE EQUITY INFUSION VALUE IS A DOLLAR AMOUNT THAT BRINGS THE PCR TO AT LEAST 1.5
IS OWNER'S INCOME OVER $28,330
YES
IF THE OWNER'S COMPENSATION IS AT LEAST $28,330 WITH THE INFUSION, THE RULE IS THE OWNER WILL SEEK THE LOAN
PLANT IS AN EQUITY INFUSION SAVE
NO
IF THE OWNER'S COMPENSATION IS BELOW $28,300 WITH THE INFUSION, THE RULE IS THE OWNER WOULD CHOOSE TO CLOSE
PLANT IS CALLED A CLOSURE

EXHIBIT B-3

Total Toxic Organics Monitoring Costs for Job Shops and IPCBs*

	Direct Dischargers		Indirect Dischargers		IPCBs	
	Costs	Affected Universe	Costs	Affected Universe	Costs	Affected Universe
Baseline Monitoring	$1904	46	$1904	418	$1904	371
Compliance Monitoring	$2890	8	$2890	76	$2890	100

* Baseline monitoring costs are one-time expenditures affecting 15.5 percent of the job shop universe. Compliance monitoring costs occur quarterly and may affect 2.8 percent of the universe. The baseline monitoring costs will affect 100 percent of the IPCBs and compliance monitoring is assumed to affect 27 percent of the IPCBs. The assumptions for cost generation are discussed in Chapter V.

EXHIBIT B-4

Option II Capital Costs for 28 Direct Discharging Model Plants

Plant ID	G.P.D.	Capital Costs ($1982)
37-85341	6	10,219
49-88571	18	25,252
357-85306	96	25,522
107-82478	800	10,917
50-81413	889	32,655
64-81761	954	11,266
71-83418	1000	39,867
423-85093	1300	64,682
416-81663	1496	100,860
409-88938	2240	10,709
80-82916	2494	22,977
82-81121	2696	116,559
110-88731	4292	88,356
136-82003	4496	144,750
194-85528	5000	68,394
313-85251	5000	68,394
176-88218	1800	57,340
127-85436	9530	90,998
42-82991	22990	288,000
331-81256	120000	113,942
284-82371	24000	219,643
50-83301	80000	20,856
89-83538	174900	151,742
162-83212	37000	227,073
250-83151	12620	228,121
182-85493	1800	15,898
357-83121	2700	65,048
152-83563	49690	93,432

EXHIBIT B-5

SAMPLE CLOSURE - MODEL PLANT 42

```
MODEL IDENTIFICATION:   42

PROJECTED:                                                   PRESENT:
                ASSETS   LIABILITIES                                           ASSETS    LIABILITIES
CURRENT          62572         35049  CURRENT       CURRENT                    62572         52403  CURRENT
FIXED+OTHER     245991        230400  LTD           FIXED+OTHER                28319             0  LTD
                               44407  NET WORTH                                              39781  NET WORTH
TOTALS          308563        309856                TOTALS                     90892         92184
DIFFERENCE(%)          -0.004                       DIFFERENCE(%)                    -0.014

                        SALES      551029                                  SALES     435829
                 DEPRECIATION       70328                           DEPRECIATION      12728
           PROFIT BEFORE TAXES      -1435                    PROFIT BEFORE TAXES       4325
            PROFIT AFTER TAXES       4626                     PROFIT AFTER TAXES       3417
                    CASH FLOW       74954                              CASH FLOW      16145
               COVERAGE RATIO       1.301                         COVERAGE RATIO     77.777
            OPERATING RATIOS:                                  OPERATING RATIOS:
        FIXED ASSET TURNOVER:       2.240                   FIXED ASSET TURNOVER:    15.390
             CASH FLOW/SALES:       0.136                        CASH FLOW/SALES:     0.037
      CASH FLOW/TOTAL ASSETS:       0.243                 CASH FLOW/TOTAL ASSETS:     0.178
               PROFITABILITY:                                      PROFITABILITY:
   PROFIT AFTER TAXES/SALES:        0.008              PROFIT AFTER TAXES/SALES:      0.008
           PAT/TOTAL ASSETS:        0.015                      PAT/TOTAL ASSETS:      0.038
              PAT/NET WORTH:        0.104                         PAT/NET WORTH:      0.086
 PAT+OWNERS COMP/NET WORTH          1.167             PAT+OWNERS COMP/NET WORTH       1.273
 CASH FLOW/CAPITALIZATION:          0.273              CASH FLOW/CAPITALIZATION:      0.639
                 LIQUIDITY:                                           LIQUIDITY:
             CURRENT RATIO:         1.785                         CURRENT RATIO:      1.194
                  LEVERAGE:                                            LEVERAGE:
              DEBT PERCENT:         0.860                          DEBT PERCENT:      0.576
            DEBT TO EQUITY:         5.188                        DEBT TO EQUITY:      0.000

  POLLUTION CONTROL COSTS:                                 PROFITABILITY CHANGES
       LEAST COST OPTION: NOT SPECIFIED                PROFIT AFTER TAXES/SALES:      0.000
            CAPITAL COST:         288000                       PAT/TOTAL ASSETS:     -0.023
                O&M COST:          34560                          PAT/NET WORTH:      0.018
             ENERGY COST:              0              PAT+OWNERS COMP/NET WORTH      -0.105
             SLUDGE COST:              0

         EQUITY INFUSION:       30211
 PERCENT OF PCC BORROWED:       0.895
       COST PASS-THROUGH:       0.264
 RETURN TO WORKING OWNER:    50636.00
       CLOSURE CATEGORY:            1
```

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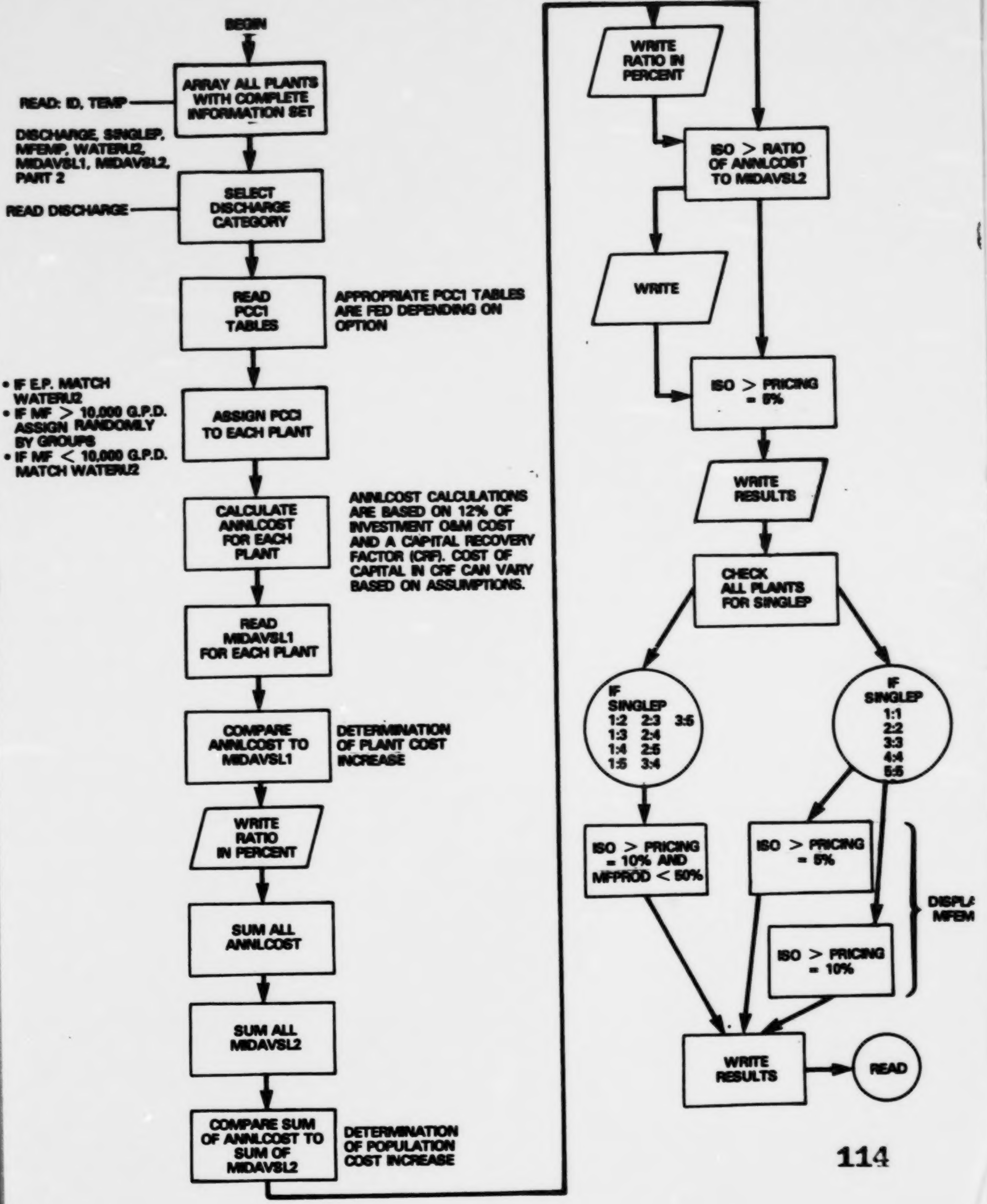
APPENDIX C

CAPTIVE PLANT ANALYSIS

EXHIBIT C-1


BEGIN
READ: ID, TEMP
ARRAY ALL PLANTS WITH COMPLETE INFORMATION SET
DISCHARGE, SINGLEP, MFEMP, WATERU2, MIDAVSL1, MIDAVSL2, PART 2
READ DISCHARGE
SELECT DISCHARGE CATEGORY
READ PCC1 TABLES
APPROPRIATE PCC1 TABLES ARE FED DEPENDING ON OPTION
• IF E.P. MATCH WATERU2
• IF MF > 10,000 G.P.D. ASSIGN RANDOMLY BY GROUPS
• IF MF < 10,000 G.P.D. MATCH WATERU2
ASSIGN PCCI TO EACH PLANT
CALCULATE ANNLCOST FOR EACH PLANT
ANNLCOST CALCULATIONS ARE BASED ON 12% OF INVESTMENT O&M COST AND A CAPITAL RECOVERY FACTOR (CRF). COST OF CAPITAL IN CRF CAN VARY BASED ON ASSUMPTIONS.
READ MIDAVSL1 FOR EACH PLANT
COMPARE ANNLCOST TO MIDAVSL1
DETERMINATION OF PLANT COST INCREASE
WRITE RATIO IN PERCENT
SUM ALL ANNLCOST
SUM ALL MIDAVSL2
COMPARE SUM OF ANNLCOST TO SUM OF MIDAVSL2
DETERMINATION OF POPULATION COST INCREASE
WRITE RATIO IN PERCENT
ISO > RATIO OF ANNLCOST TO MIDAVSL2
WRITE
ISO > PRICING = 5%
WRITE RESULTS
CHECK ALL PLANTS FOR SINGLEP
IF SINGLEP 1:2 2:3 3:5 1:3 2:4 1:4 2:5 1:5 3:4
IF SINGLEP 1:1 2:2 3:3 4:4 5:5
ISO > PRICING = 10% AND MFPROD < 50%
ISO > PRICING = 5%
ISO > PRICING = 10%
DISPLA
MFEM
WRITE RESULTS
READ

APPENDIX C

CAPTIVE PLANT ANALYSIS

This Appendix serves to introduce the captive impact routine, to define its key variables, cost inputs, and to illustrate its operational flow logic. It is designed to utilize as primary inputs the cost of compliance information developed by the technical contractor and the Environmental Protection Agency, and plant specific information on 1087 captive plants gathered in the 1976 survey of the metal finishing universe. The routine was designed by the economic contractor to best utilize existing technical and economic data bases, in order to project the impacts of the proposed regulation.

The routine generates information on the following:

- Annual and investment costs per plant and the universe
- Projected cost increases for the universe and each model plant
- Projected plant closures and divestitures

This appendix is organized into the following sections:

- Variable definitions - defines all the variables in the computerized impact routine
- Program flow chart - describes the impact routine's logic and inputs
- Costs of compliance - describes the actual cost inputs into the impact routine and explains the manner with which they were compiled
- Summary of impacts
- Effects on return on investment and international trade.

1. VARIABLE DEFINITIONS

The variables listed below make up the captive impact routine. Most of the variables' values were derived from the 1976 survey of the metal finishing universe. Cost variable inputs were derived by the technical contractor and inputed by the economic contractor. Some variables are generated by the routine itself.

1) ID - Identification number for each plant in the data base
2) TEMP - Total employment in each plant
3) Discharge - Direct or Indirect Discharger
4) SINGLEP - Whether the plant is a part of a multi-plant firm
5) MFEMP - Metal finishing employment in plant
6) WATERU2 - Metal finishing process water use
7) PCC1 - Investment costs
8) MIDAVSL1 - Sales volume of the plant
9) MIDAVSL2 - Sales volume of the firm
10) PART2 - Percentage of finishing services provided to outside customers
11) ANNLCOST - Annual per-plant and universe costs
12) PRICINC - Projected increase in costs per plant
13) APRICINC - Average cost increase for entire universe or segments of universe
14) ISO - Isolates plants according to cost increase categories
15) MFPROD - Percentage of products that receive metal finishing

2. PROGRAM FLOW CHART

The program flow chart (Exhibit C-1) is a guide to the computerized impact routine and its logic. It shows the actual steps taken to estimate candidates for closure or divestitute, and calculates costs and cost increases. The routine utilizes cost inputs which are exhibited in Section 3 of this Appendix. The logic of the routine centers around two elements:

- Computation of per-plant cost increase
- Decision rules for plant closures and divestitures.

(1) Computation of Cost Increases

The computation of the per plant cost increase is simply a division of the plant's estimated annual cost of compliance for any regulatory option by the annual sales volume of that plant. In the program flow chart this appears as the comparison of variable ANNLCOST to variable MIDAVSL1. A division of the summation of all the plants' annual costs by a summation of their total sales yields the cost increase for the entire universe.

(2) Decision Rules for Plant Closures

Decision rules were developed to utilize existing data and arrive at meaningful economic projections.

The decision rules to project a plant as a closure are the following:

- Any plant with a projected cost increase of 5 percent or more, and outside customers amounting to at least 50 percent of the total revenue
- Any plant with a projected cost increase of 10 percent or more.

The decision rule for metal finishing divestitures is that all multi-plant corporations whose metal finishing production plant will experience a cost increase of 10 percent or more will divest of the metal finishing operation.

The decision rules were determined judgmentally based on the assumption that plants with a projected cost increase higher than the decision rules, especially when those are higher than the industry average will not be able to raise prices by an amount equal to their added costs and will close down.

Exhibit C-1 shows the operation of the decision rules for plant closures and divestitures. The logic centers around the projected cost of production increase for a plant. That cost increase is computed as the ratio of the annual costs of compliance and the annual sales of the plant. In the flow chart it is shown as the comparison of variables ANNLCOST to MIDAVSL1. The per-plant cost increase is compared with the weighted average cost increase of all the sample plants. If it is lower it is dropped from further closure consideration. All single plant firms, those that are shown in the chart as 1:1, 2:2, 3:3, 4:4, 5:5 (the numbers stand for sales values where 1 is $1 million, 2 is $5 million, 3 is $25 million, 4 is $50 million, and 5 is $100 million. For example, a 1:1 firm is a single plant operation with sales of 1 million) with higher than average cost increases are compared with a 5 percent cost increase cutoff. If their cost increase is higher they are projected to close. The 5 percent cutoff was used rather than the average because of the low industry average (below 1 percent). Five percent was judged appropriate due to the inelastic nature of the demand for metal finishing. In other words, a firm could withstand up to a five percent increase in the cost of operation due to compliance with this regulation without jeopardizing its economic viability.

For multi-plant corporations, i.e., those depicted in Exhibit C-1 as 1:2, 1:3, 1:4, 1:5, 2:3, 2:4, 2:5, 3:4, 3:5 (a 1:3 plant has sales of 1 million but is part of a firm whose sales are $25 million) the cut-off was determined to be 10 percent increase on costs for the plant. The reason for the closure criteria differential between single plant firms and multi plant firms is that parent corporations conduct in-house finishing operation for advantageous economic reasons, i.e., cost advantages. It is in a parent corporation's interest to maintain these advantages. This is especially true if a metal finished good from one profit center plant is used as an input to another profit center plant's process.

All the results were extrapolated in a straight line to that universe. The relationship of the number of model plants to the actual in the universe is shown below:

	Model Plants	Universe
Directs	231	2500
Total Indirects	856	7500
Indirects (under 10,000 GPD)	326	2850

3. COSTS OF COMPLIANCE

Technical cost estimates were developed by the technical contractor and the Environmental Protection Agency. The grouping and application of these costs was performed by the economic contractor.

(1) Direct Discharging Captives

The technical contractor generated investment cost estimates for 100 of its model plants that are direct dischargers. Costs were produced for option I regulatory requirements and Option II regulatory requirements. As discussed in Chapter V of the report, Agency surveys determined that all 2500 direct discharging captives have the necessary equipment to meet Option I requirements. All direct discharging captives will have to make additional investments to meet Option II requirements. The technical contractor's cost data for Option II was grouped by metal finishing water use categories, it is displayed in Exhibit C-2. The cost groupings were then matched according to water usage with the 231 direct discharging model plants in the economic data base.

In addition to the equipment-based costs generated by the technical contractor, the Environmental Protection Agency estimated the additional per plant costs of monitoring for total toxic organics. These costs shown are in Exhibit C-3 and are part of the Option I regulatory requirements. Exhibit C-4 displays a list of 231 direct discharging captive model plants and the associated Option I costs. The total toxic organics costs were applied randomly to the model plant population. For example, plant number 85 in Exhibit C-4 has a flow of 60,000 GPD. The plant's annual Option I costs (TTO limits alone) are estimated to be $2,890. Option II annual cost for this plant are $26,426 as shown in Exhibit C-2.

(2) Indirect Discharging Captives

The indirect discharging segment of the metal finishing universe was costed for the following:

- Electroplating baseline costs
- Metal finising flow costs for Option I
- Total toxic organics monitoring costs
- Option II costs.

1. Electroplating Baseline Costs -- The technical contractor, developed costs for the electroplating flow of 100 of their model plants. These costs were grouped into six water usage categories so that matching with the economic contractor was possible. Exhibit C-5 displays these electroplating baseline cost groupings for integrated indirect discharging captive plants. The technical contractor data base showed that there were no integrated plants under 10,000 G.P.D. Therefore, no costs were attributed to them.

2. Metal Finishing Flow Costs for Option I -- The technical contractor developed total metal finishing flow estimates for 100 of their model plants. These same plants were also costed for their electroplating flow. The technical data showed that only 26 of the 100 model plants had metal finishing flow beyond their electroplating water flow. The difference between the costs associated with the metal finishing flow and the electroplating flow for the 26 model plants constitute Option I compliance cost estimates. Exhibit C-6 shows the cost of the metal finishing portion of total flow for the 26 integrated plants in the technical data base. The relationship between the cost and total plant water flow could not be established on a per plant basis; therefore, the costs were matched with the 530 model plants in the economic data base in a random fashion. Exhibit C-7 shows the cost groupings for the metal finishing flow alone. The costs within each water flow category were matched randomly with Booz, Allen model plants in the same flow category. Exhibit C-8 shows a list of all indirect discharging model plants with water usage greater than 10,000 G.P.D. and their associated Option I costs. The results were extrapolated to the universe of 1200 plants.

   (1) Costs for Indirect Discharging Captives Under 10,000 G.P.D. -- The technical contractor Generated Option I compliance cost estimates for this segment. The average cost for plants in this segment that must invest in pollution control equipment is $12,633 annually. There are an estimated 2,850 indirect discharges with water use of less than 10,000 G.P.D. A total of 912 have to make investments to meet Option I compliance levels. The remaining were found by agency surveys to be in compliance. Exhibit C-9 shows a list of all model plants in the economic data base with water usage of less than 10,000 G.P.D. and their associated compliance costs.

3. Monitoring Costs for Total Toxic Organics -- The Environmental Protection Agency

developed monitoring costs for total toxic organics. These costs are shown in Exhibit C-2. It is assumed that 36 percent of all indirect discharging captive facilities will have to one-time baseline monitor, and 6.5 percent will be required to compliance monitor on an annual basis.

4. Option II Costs -- The technical contractor generated Option II costs for 100 of their indirect discharging model plants. The incremental costs of achieving Option II compliance levels from Option I were grouped according to water usage categories. These groupings are displayed in Exhibit C-10. These costs were matched with all 856 Booz, Allen indirect discharging model plants and extrapolated to the universe of 7500.

4. SUMMARY OF IMPACTS

(1) Option I

No captive plant closures on divestitures were associated with Option I compliance levels. None of the 530 indirect discharging model plants whose water use level is greater than 10,000 G.P.D had a cost increase of greater than 5 percent. The distribution of cost increases in percent is the following:

- 0-1 Percent -- 507 plants
- 1-2 Percent -- 20 plants
- 2-3 Percent -- 3 plants.

Only 25 of the indirect discharging captive model plants with water usage of less than 10,000 G.P.D had cost increases of 1.3 percent or more. The other 226 experience a cost increase of less than one percent.

(2) Option II

The distribution of cost increases for the 856 indirect discharging captive model plants in Option II is the following:

- 0-1 percent -- 471
- 1-2 percent -- 356
- 2-3 percent -- 21
- 3-4 percent -- 7
- Greater than 5 percent -- 1

One model plant out of 856 indirect discharging model plants was projected to close under Option II. This translates into 8 plants in the universe. The cost increase distribution for the 231 direct discharging model plants in Option II is the following:

- 0-1 percent -- 149
- 1-2 percent -- 58
- 2-3 percent -- 19
- 3-4 percent -- 2
- Greater than 5 percent -- 3

A total of 3 model plants had cost increases greater than 5 percent. One model plant was projected to close and 2 model plants projected to divest. This translates into 10 plant closures and 21 divestitures in the universe of direct discharging captives.

Plant number 300 in Exhibit C-4 is a direct discharging plant with water use of 261,800 G.P.D. Exhibit C-2 shows that his annual compliance cost for Option II is $76,653, which accounts for more than 7 percent of the plant sales. Since this plant is a single plant facility that provides 80 percent of its services to outside customers it is projected to be a closure.

5. EFFECTS ON RETURN ON INVESTMENT AND INTERNATIONAL TRADE

(1) Regulatory Effects on Investment

The analysis of the impacts on investment for the captive sector consists of a comparison of investment for regulatory compliance and annual fixed investment in SIC Code 34-38. Specific financial information on captives is not available, but aggregate annual investment data does exist for SIC's 34-38 which include most metal finishing facilities.

Total annual compliance investment at Option I for captives is $116.9 million. This is compared to total investment in plant and equipment for SICs 34-38, estimated for 1982 by Data Resources Incorporated, as being $46.6 billion.[1] Compliance investment is less than 0.3 percent of total industry investment. This is a relatively small proportion of total investment, and should not affect capital availability or long-term capital growth in the industry.

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[1] U.S. Long-Term Review, Data Resources, Inc., Table 3-8, p. 1.69.

The annual Option II compliance costs for captives are $480 million. This is approximately 1 percent of industry's total projected investment (compared to 0.3% for Option I). This percentage of total investment should not affect capital availability or long-term capital growth in the industry.

(2) International Trade Effect

In general, effects on international trade will be driven by changes in the relative prices of metal finishing products. In order to determine whether the U.S. trade balance will deteriorate following a price hike of U.S. export products following compliance with the metal finishing regulation, the Marshall-Lerner condition that the sum of U.S. impact demand elasticity and export supply elasticity for metal finished products exceeds unity must hold. That is, the elasticity of U.S. demand for foreign metal finished products and the elasticity of U.S. supply for metal finished products must add up to more than one in order for U.S. trade deficit in these products to persist.

Metal finishing processes are utilized as inputs to production in many 4-digit SICs, each with unique demand and international trade conditions. U.S. demand for domestic and foreign metal finished products could be estimated from a U.S. import demand model relating import volume to relative prices of domestic to imported metal finishing products. However, given that the estimated increase in the cost and thus price of domestic metal finished products is on the order of one tenth of one percent, the impact on international trade would be immeasurably small and could not be detected by any economic model. In addition, the variability in the relative prices of international currencies due to floating exchange rates exerts a continuous and far greater impact on the terms of trade than a small increase in the domestic price of the goods.

EXHIBIT C-2

Option II Plant Cost Groups for Direct Discharging Captives*

Plant G.P.D. Category	Investment Cost	Annual Cost**
0 - 10,000	25,500	8,415
10,001 - 25,000	49,043	16,184
25,001 - 75,000	80,080	26,426
75,001 - 200,000	145,600	48,048
200,001 - 500,000	231,375	76,353
Greater than 500,000	435,800	154,814

* The technical contracotr determined the investment cost for treating 100 model plants. The 100 model plants were grouped into the six water flow categories shown. The investment cost corresponding to a particular water flow category represents the average investment cost for plants falling within that water flow category. The investment costs were annualized according to the methodology specified in Appendix A.

** These costs represent the marginal cost of achieving Option II compliance from Option I baseline.

EXHIBIT C-3

COST OF MONITORING FOR TOTAL TOXIC ORGANICS FOR CAPTIVES*

	Indirect Dischargers		Direct Dischargers	
	Costs	Affected Universe	Costs	Affected Universe
Baseline Monitoring	$1904	2700	$1904	900
Compliance Monitoring	$2890	487	$2890	162

* Baseline monitoring are one time costs affecting an estimated 36 percent of the captive universe. Compliance monitoring are annual costs affecting an estimated 6.5 percent of the captive universe. Cost estimates provided by the Environmental Protection Agency. The assumptions for cost generation are discussed in Chapter V.

EXHIBIT C-4

OPTION I COSTS ($ 1982) DIRECT DISCHARGING CAPTIVES**

ID	Metal Finishing Waterflow	Annual Sales (Millions)	% Metal Finishing Customers	Baseline Monitoring	Compliance Monitoring	Facility*
4	95,000	5	10	0	0	MP
6	40,000	50	0	1,904	0	SP
7	150,000	50	20	1,904	0	MP
15	200,000	100	0	0	0	SP
24	52,000	25	0	0	0	MP
29	450,000	100	5	0	0	SP
32	60,000	25	1	1,904	0	SP
33	17,500	5	0	0	0	SP
41	900,000	100	15	1,904	2,890	SP
42	1,500,000	100	10	0	0	SP
56	300,000	100	2	0	0	SP
58	29,305,440	50	0	1,904	0	SP
60	100,000	25	0	0	0	SP
70	900,000	100	0	1,904	0	SP
74	11,000	1	5	0	0	MP
79	200,000	25	1	1,904	0	MP
81	24,000	50	0	0	0	MP
82	344,000	50	0	0	0	MP
84	33,000	50	0	1,904	0	MP
85	60,000	50	25	1,904	2,890	MP
87	50,000	50	0	0	0	MP
88	20,000	25	2	0	0	MP
89	180,000	100	14	0	0	SP
91	20,000	50	0	0	0	MP
93	300,000	100	0	1,904	0	SP

*MP = Multi-Plant
SP = Single Plant

** These reflect only total toxic organics monitoring costs.

ID	Metal Finishing Waterflow	Annual Sales (Millions)	% Metal Finishing Customers	Baseline Monitoring	Compliance Monitoring	Facility*
95	50,000	50	0	1,904	0	MP
96	18,000	5	0	0	0	SP
100	200,000	50	0	0	0	SP
104	250,000	50	1	0	0	MP
107	600,000	100	20	0	0	SP
108	100,000	50	0	0	0	SP
113	528,000	1	0	1,904	0	SP
117	65,000	50	0	0	0	MP
118	15,000	5	0	0	0	SP
121	20,000	25	2	1,904	0	SP
123	125,000	50	1	0	0	MP
138	30,000	50	0	1,904	0	SP
141	300,000	100	15	0	0	SP
142	222,000	100	0	0	0	SP
144	500,000	100	0	0	0	SP
155	40,000	25	0	0	0	MP
157	260,000	25	5	1,904	0	MP
158	100,000	100	10	1,904	0	SP
161	240,000	25	0	0	0	MP
167	30,000	25	0	0	0	MP
172	45,000	50	0	1,904	2,890	MP
173	70,000	50	0	1,904	0	SP
178	200,000	25	0	1,904	2,890	MP
184	50,000	25	5	0	0	MP
190	25,000	50	0	0	0	MP
201	32,000	100	0	1,904	0	SP
206	34,000	100	1	0	0	SP
209	100,000	50	2	0	0	MP
214	150,000	100	0	1,904	0	SP
215	200,000	50	1	0	0	SP
217	35,000	100	1	1,904	0	SP

*MP = Multi-Plant
SP = Single Plant

ID	Metal Finishing Waterflow	Annual Sales (Millions)	% Metal Finishing Customers	Baseline Monitoring	Compliance Monitoring	Facility*
218	83,000	5	0	0	0	MP
223	50,000	50	15	1,904	0	MP
230	43,000	5	10	0	0	MP
237	200,000	100	1	0	0	SP
242	70,000	100	0	0	0	SP
243	20,000	25	0	0	0	SP
244	86,400	50	0	0	0	SP
245	209,000	50	0	0	0	MP
259	25,000	50	0	0	0	MP
260	50,625	5	0	0	0	MP
264	375,000	100	0	0	0	SP
266	20,000	100	0	1,904	0	SP
267	169,048	50	0	1,904	0	MP
269	53,000	5	0	0	0	SP
292	191,500	100	10	1,904	2,890	SP
298	140,000	50	0	0	0	SP
314	187,000	100	1	0	0	SP
318	200,000	100	5	1,904	0	SP
327	42,307	25	0	1,904	0	MP
328	55,000	50	0	0	0	MP
330	30,000	100	0	1,904	0	SP
335	50,000	50	0	0	0	MP
336	300,000	100	0	1,904	0	SP
341	85,000	50	0	0	0	MP
344	512,640	50	0	0	0	SP
345	33,180	50	10	1,904	2,890	MP
351	144,000	50	0	0	0	MP
352	25,000	50	0	0	0	MP
354	100,000	5	0	0	0	MP
361	200,000	100	13	0	0	SP
364	15,000	25	40	0	0	MP

*MP = Multi-Plant
SP = Single Plant

ID	Metal Finishing Waterflow	Annual Sales (Millions)	% Metal Finishing Customers	Baseline Monitoring	Compliance Monitoring	Facility*
366	125,000	50	0	0	0	SP
368	70,000	50	5	0	0	MP
371	500,000	100	0	0	0	SP
374	40,000	50	0	0	0	MP
376	40,000	5	0	1,904	0	SP
377	40,000	5	0	0	0	MP
380	261,800	1	80	1,904	0	SP
396	15,000	5	0	1,904	0	SP
400	150,000	100	0	0	0	SP
401	83,000	25	45	0	0	MP
408	47,500	50	20	1,904	2,890	SP
409	86,400	100	0	1,904	0	SP
413	220,000	25	0	0	0	MP
423	80,000	5	0	0	0	MP
442	30,000	5	0	0	0	SP
448	150,000	50	0	1,904	0	MP
450	230,00	25	0	0	0	MP
453	28,000	50	0	1,904	0	MP
456	50,000	5	0	0	0	MP
460	158,400	50	0	0	0	MP
464	25,000	100	7	1,904	0	SP
468	673,200	50	0	0	0	MP
479	180,000	25	0	1,904	0	SP
480	200,000	25	20	1,904	0	MP
485	275,000	50	10	0	0	MP
496	78,000	25	0	0	0	MP
501	50,000	50	0	0	0	MP
506	100,000	25	0	1,904	0	MP
515	13,260	100	0	0	0	SP
528	20,000	5	85	0	0	MP
530	20,000	50	10	1,904	0	MP

*MP = Multi-Plant
SP = Single Plant

ID	Metal Finishing Waterflow	Annual Sales (Millions)	% Metal Finishing Customers	Baseline Monitoring	Compliance Monitoring	Facility*
531	518,000	50	0	0	0	MP
532	85,000	25	0	0	0	SP
535	45,000	5	0	1,904	0	SP
538	15,000	25	0	1,904	2,890	MP
541	280,000	100	0	0	0	SP
546	15,000	25	0	0	0	MP
547	40,000	1	0	0	0	MP
551	23,000	50	0	0	0	MP
554	288,000	50	5	1,904	0	MP
558	48,000	50	0	1,904	2,890	MP
561	30,000	50	33	0	0	MP
575	90,000	100	0	0	0	SP
586	150,000	50	0	0	0	MP
590	400,000	50	0	1,904	0	MP
592	35,000	5	0	0	0	MP
597	200,000	50	1	0	0	MP
599	615,000	1	40	0	0	MP
601	180,000	50	35	1,904	0	MP
606	51,000	50	0	0	0	MP
609	74,800	100	0	0	0	SP
614	20,000	50	4	1,904	0	MP
618	5,700,000	100	0	1,904	0	SP
627	15,000	50	0	1,904	0	MP
632	15,000	50	0	0	0	MP
634	99,000	5	0	0	0	MP
635	500,000	50	15	1,904	0	MP
636	60,000	50	0	0	SP	
639	150,000	50	0	0	0	MP
642	100,000	50	0	0	0	MP
643	25,000	1	0	1,904	2,890	SP
647	250,000	100	1	1,904	0	SP

*MP = Multi-Plant
SP = Single Plant

ID	Metal Finishing Waterflow	Annual Sales (Millions)	% Metal Finishing Customers	Baseline Monitoring	Compliance Monitoring	Facility*
648	120,000	25	20	0	0	MP
649	60,000	25	0	0	0	SP
650	20,000	25	0	0	0	MP
651	132,152	100	0	0	0	SP
653	120,000	100	1	1,904	0	SP
656	24,000	25	10	1,904	0	MP
662	50,000	50	15	0	0	MP
665	50,000	100	5	0	0	SP
673	35,000	100	0	1,904	2,890	SP
674	600,000	100	0	0	0	SP
676	115,000	50	0	0	0	MP
678	200,000	50	1	0	0	MP
689	150,000	100	30	1,904	0	SP
692	11,968	50	2	0	0	MP
694	2,000,000	100	1	0	0	SP

*MP = Multi-Plant
SP = Single Plant

EXHIBIT C-5

Electroplating Baseline Compliance Costs ($1982) For Integrated Indirect Discharging Plants*

Plant G.P.D. Category	Investment Cost	Annual Cost
10,000 - 25,000	121,750	40,200
25,001 - 75,000	191,150	63,100
75,001 - 200,000	273,600	90,000
200,001 - 500,000	597,250	197,000
Greater than 500,000	1,281,500	422,900

* Costs were grouped into gallons per day categories by the economic contractor from data on 100 model plants supplied by the technical contractor.

EXHIBIT C-6

Option 1 Investment Costs ($1982) for the Metal Finishing Portion Of Total Flow for 26 Model Plants*

Plant ID	Water Flow (G.P.D)	Investment Cost	Annual Costs
1063	114,610	2,560	844
2036	350,000	234,143	77,267
2045	69,700	8,636	2,757
4132	216,000	3,563	1,175
6084	108,800	3,293	1,086
6129	51,880	213,300	70,400
8061	21,010	233	77
9036	23,560	15,420	5,090
11123	29,880	54,623	18,025
11155	31,700	62,743	20,705
12082	40,400	22,360	7,380
17030	479,600	551,130	181,872
20173	383,900	374,290	123,515
28083	25,300	95,243	31,430
28116	836,000	913,726	301,529
28117	36,480	159,396	52,600
30063	425,680	301,566	99,500
34037	89,940	171,115	56,479
45031	607,540	1,038,196	342,604
45034	81,616	249,606	82,370
47035	781,800	1,022,136	337,305
47048	54,080	125,240	41,320
47059	254,130	468,426	154,580
47062	19,120	7,956	2,625
62032	198,700	75,276	24,841
3041	311,900	471,890	155,724

* Of the 100 indirect discharging model plants in the technical data base, only 26 had metal finishing water flow in excess of their electroplating flow.

EXHIBIT C-7

Metal Finishing Plant Cost Grouping for Option I*

Plant G.P.D. Category	Investment Cost	Annual Cost
10,000 - 25,000	233	77
	7,956	2,625
	15,420	5,090
25,001 - 75,000	8,356	2,757
	213,300	70,400
	54,623	18,025
	62,743	20,705
	22,360	7,380
	95,243	31,430
	159,296	52,600
	125,240	41,330
75,001 - 200,000	2,560	844
	3,293	1,086
	75,276	24,841
	171,115	56,479
	249,606	82,370
200,001 - 500,000	234,143	77,267
	3,563	1,175
	551,130	181,872
	374,290	123,515
	301,566	99,500
	468,426	154,580
	471,890	155,724
Greater than 500,000	913,726	301,529
	1,038,196	342,604
	1,022,136	337,305

* In the impact routine - costs were randomly assigned to plants in the various water use categories

EXHIBIT C-8

OPTION I COSTS FOR INDIRECT DISCHARGING MODEL PLANTS WITH WATER USE GREATER THAN 10,000 G.P.D.

ID	Metal Finishing Waterflow	Annual Sales (Millions)	% Metal Finishing Customers	Annual* Compliance Costs	Facility**
1	25,000	5	0	5,090	MP
2	107,140	5	0	844	MP
3	15,000	25	0	77	SP
5	16,000	5	0	2,625	MP
8	12,000	1	0	5,090	MP
9	159,000	50	0	24,841	MP
10	19,000	1	0	2,625	MP
11	125,000	50	0	844	MP
12	200,000	100	0	77,267	SP
13	130,546	50	0	56,479	SP
14	141,000	50	0	1,086	MP
16	25,000	50	0	2,757	MP
17	12,500	5	0	2,625	SP
18	100,000	100	0	82,370	SP
19	175,266	50	0	56,479	SP
20	162,000	50	0	24,841	MP
21	12,000	50	0	5,090	MP
22	150,000	25	0	24,841	SP
23	28,000	1	60	7,380	MP
25	113,640	25	0	1,086	SP
26	40,000	5	0	20,705	MP
27	50,000	25	25	7,380	MP
28	145,000	20	5	82,370	SP

** Does not include monitoring costs for total toxic organics.

* MP = Multi-Plant
SP = Single Plant

ID	Metal Finishing Waterflow	Annual Sales (Millions)	% Metal Finishing Customers	Annual Compliance Costs	Facility*
30	44,000	50	0	31,430	MP
31	25,000	5	0	5,090	MP
34	131,325	50	57	56,479	MP
35	250,000	100	0	181,872	SP
36	285,000	100	10	99,500	SP
37	40,000	50	0	41,330	MP
38	400,000	100	5	181,872	SP
39	200,000	50	0	56,479	MP
40	25,000	25	0	70,400	MP
43	90,000	25	0	1,086	MP
44	180,000	50	0	3,293	SP
45	42,750	5	0	7,380	MP
46	150,000	50	20	82,370	MP
47	20,000	50	0	2,625	SP
48	24,000	5	0	5,090	MP
49	128,806	5	0	56,479	SP
50	80,000	50	0	24,841	SP
51	39,000	1	80	2,757	SP
52	40,000	25	0	7,380	MP
53	15,000	50	17	5,090	MP
54	50,000	50	0	18,025	MP
55	45,000	25	0	31,430	MP
57	365,000	50	0	123,515	SP
59	150,000	100	10	844	SP
61	60,000	25	0	41,330	MP
62	28,909	100	0	31,430	SP
63	299,200	50	0	1,175	SP
64	51,201	5	0	52,600	SP
65	11,000	5	0	2,625	SP
66	50,000	50	5	70,400	SP
67	25,000	5	2	2,757	MP
68	50,000	50	0	20,705	SP
69	40,000	25	0	70,400	MP
71	880,000	100	0	337,305	SP
72	90,000	25	0	844	SP
73	35,000	50	0	31,430	SP
76	21,000	50	10	77	MP

ID	Metal Finishing Waterflow	Annual Sales (Millions)	% Metal Finishing Customers	Annual Compliance Costs	Facility*
77	70,000	50	0	18,025	MP
78	95,000	50	5	56,479	SP
80	17,300	5	10	2,625	MP
83	12,800	1	0	77	MP
86	30,500	50	0	31,430	MP
90	30,000	5	1	77	MP
92	327,000	50	0	181,872	MP
94	180,000	50	0	82,370	MP
97	225,000	50	5	77,267	MP
98	500,000	100	0	155,724	SP
99	35,000	50	0	52,600	MP
101	240,000	100	55	123,515	SP
102	25,000	50	0	2,757	MP
103	30,000	50	15	52,600	MP
105	192,000	1	90	24,841	SP
106	130,000	25	0	24,841	MP
109	22,440	100	35	77	SP
110	175,000	50	0	56,479	SP
111	12,000	50	0	2,625	MP
112	25,000	100	5	7,380	SP
114	400,000	100	0	1,175	SP
115	1,100,000	50	0	342,604	MP
116	190,000	50	20	1,086	MP
119	50,000	50	5	20,705	MP
120	40,000	50	0	41,330	MP
122	20,000	25	5	5,090	MP
124	165,000	1	75	24,841	MP
125	37,500	50	5	31,430	MP
126	45,000	50	35	41,330	MP
127	25,000	50	0	2,757	MP
128	350,000	100	1	1,175	SP
129	50,000	5	25	7,380	MP
130	200,000	100	0	844	SP
131	42,000	50	0	70,400	MP
132	96,000	50	0	844	SP
133	200,000	100	0	82,370	SP
134	14,000	50	0	2,625	MP

ID	Metal Finishing Waterflow	Annual Sales (Millions)	% Metal Finishing Customers	Annual Compliance Costs	Facility*
135	30,000	100	0	20,705	SP
136	108,000	50	2	1,086	MP
137	74,000	50	25	31,430	MP
139	240,000	50	0	77,267	MP
140	20,000	50	0	5,090	SP
143	175,000	100	0	844	SP
145	7,199,994	50	75	337,305	SP
146	35,000	5	0	7,380	MP
147	37,500	25	1	2,757	MP
148	25,000	50	0	77	MP
149	148,000	5	1	24,841	MP
150	200,000	50	10	82,370	SP
151	220,000	50	100	99,500	MP
152	96,800	50	0	82,370	MP
153	40,000	50	0	18,025	MP
154	82,000	100	5	844	SP
156	28,000	5	0	7,380	SP
159	30,000	5	0	77	MP
160	450,000	50	0	1,175	MP
162	100,000	50	0	844	MP
163	59,840	25	1	2,757	MP
164	13,000	5	0	2,625	MP
165	44,880	5	5	70,400	MP
166	12,000	5	0	2,625	SP
168	26,928	1	0	7,380	MP
169	974,185	100	0	301,529	SP
170	216,000	50	45	77,267	MP
171	38,400	50	100	18,025	MP
174	16,000	25	0	5,090	MP
175	39,000	50	0	2,757	MP
176	20,000	50	0	2,625	MP
177	86,000	50	0	56,479	MP
179	50,000	50	1	20,705	SP
180	70,000	100	0	7,380	SP
181	96,000	25	2	24,841	MP
182	390,000	50	0	77,267	SP
183	110,000	50	0	844	SP

ID	Metal Finishing Waterflow	Annual Sales (Millions)	% Metal Finishing Customers	Annual Compliance Costs	Facility*
185	110,000	50	0	24,841	MP
186	80,000	1	80	1,086	SP
187	20,000	1	0	5,090	MP
188	40,000	50	0	70,400	SP
189	250,000	25	0	99,500	SP
191	500,000	50	0	123,515	MP
192	470,000	50	0	1,175	SP
193	161,000	5	0	82,370	SP
194	700,000	100	0	342,604	SP
195	40,000	50	3	31,430	SP
196	100,000	50	1	844	MP
197	30,000	25	0	52,600	MP
198	10,600	5	0	77	MP
199	30,000	5	0	70,400	SP
200	972,400	50	0	342,604	SP
202	50,400	50	0	18,025	SP
203	200,000	50	0	82,370	MP
204	300,000	50	0	181,872	MP
205	45,000	50	10	7,380	SP
207	55,400	25	0	31,430	SP
208	20,000	100	0	77	SP
210	28,000	100	0	2,757	SP
211	1,100,000	100	5	337,305	MP
212	20,000	50	0	77	SP
213	1,000,000	50	5	342,604	MP
216	90,000	25	0	1,086	SP
219	83,000	5	0	82,370	MP
220	100,100	5	80	844	SP
221	200,000	50	5	77,267	MP
222	796,700	100	0	301,529	SP
224	200,000	50	0	844	MP
225	40,000	50	20	41,330	MP
226	600,000	25	0	342,604	MP
227	59,000	5	0	31,430	SP
228	80,000	50	15	1,086	MP
229	187,000	50	0	82,370	SP
231	200.000	50	5	82,370	MP

ID	Metal Finishing Waterflow	Annual Sales (Millions)	% Metal Finishing Customers	Annual Compliance Costs	Facility*
232	25,000	100	0	70,400	SP
233	193,500	50	5	844	SP
234	90,000	50	2	1,086	MP
235	30,000	50	0	2,757	MP
236	13,000	50	0	77	MP
238	375,000	5	0	123,515	MP
239	100,000	50	0	1,086	SP
240	90,000	5	0	24,841	MP
241	20,000	50	0	2,625	MP
246	300,000	1	1	77,267	MP
247	20,000	25	0	77	SP
248	30,000	100	1	18,025	SP
249	250,000	100	0	77,267	SP
250	100,000	100	58	24,841	SP
251	50,000	1	50	41,330	SP
252	109,500	50	0	82,370	MP
253	20,000	5	0	2,625	MP
254	13,000	50	5	5,090	SP
255	48,000	50	0	18,025	SP
256	32,723	25	0	70,400	SP
257	79,000	50	25	844	MP
258	200,000	100	0	24,841	SP
261	50,000	50	5	20,705	MP
262	25,000	100	95	52,600	SP
263	40,000	5	0	41,330	MP
265	30,668	50	0	52,600	MP
268	60,000	5	5	20,705	SP
270	270,000	100	0	1,175	SP
271	100,000	100	5	844	SP
272	17,280	50	1	2,625	MP
273	60,000	25	0	20,705	SP
274	18,000	1	10	5,090	SP
275	148,000	5	100	1,086	MP
276	30,000	25	2	18,025	SP
277	100,000	50	0	844	MP
278	87,000	5	0	82,370	SP
279	450,000	25	0	1,175	SP

ID	Metal Finishing Waterflow	Annual Sales (Millions)	% Metal Finishing Customers	Annual Compliance Costs	Facility*
280	210,000	1	0	1,175	MP
281	28,150	5	2	2,757	SP
282	15,000	50	0	77	SP
283	87,700	50	0	1,086	SP
284	25,000	5	0	2,757	SP
285	18,526	5	0	5,090	SP
286	20,000	5	0	2,625	MP
287	100,000	100	40	844	SP
288	35,000	25	2	70,400	SP
289	11,000	100	0	2,625	SP
290	110,000	100	0	56,479	SP
291	70,000	100	0	7,380	SP
293	16,000	25	0	2,625	SP
294	25,000	50	0	77	MP
295	55,000	50	5	20,705	MP
296	90,000	25	0	1,086	SP
297	26,000	50	0	70,400	MP
299	20,000	50	0	5,090	MP
300	95,000	50	1	56,479	MP
301	52,000	50	5	31,430	MP
302	75,000	50	1	18,025	MP
303	22,500	50	0	5,090	MP
304	38,535	5	0	7,380	MP
305	200,000	100	3	181,872	SP
306	150,000	50	3	24,841	MP
307	100,000	50	0	844	MP
308	750,000	100	5	99,500	SP
309	340,000	100	25	154,580	SP
310	200,000	100	10	155,724	SP
311	19,000	50	1	2,625	MP
312	300,000	100	5	123,515	SP
313	85,000	100	0	56,479	SP
315	15,500	25	0	5,090	MP
316	70,000	25	2	7,380	MP
317	38,000	5	0	31,430	MP
319	100,000	50	0	24,841	MP
320	44,000	25	0	7,380	MP

ID	Metal Finishing Waterflow	Annual Sales (Millions)	% Metal Finishing Customers	Annual Compliance Costs	Facility*
321	37,800	100	25	31,430	SP
322	31,000	25	2	2,625	MP
323	250,000	100	0	123,515	SP
324	116,000	50	0	1,086	MP
325	15,000	25	0	5,090	MP
326	40,000	100	1	7,380	SP
329	43,000	50	0	7,380	MP
331	22,440	5	30	2,625	SP
332	80,000	100	0	41,330	SP
333	50,000	50	0	2,757	MP
334	96,000	50	10	52,600	MP
337	72,000	50	50	18,025	MP
338	500,000	50	0	77,267	SP
339	18,000	50	0	2,625	SP
340	1,157,000	100	3	301,529	SP
342	19,670	25	0	77	SP
343	80,000	50	0	24,841	MP
346	70,000	5	0	31,430	MP
347	60,000	5	0	31,430	MP
348	18,000	50	1	77	MP
349	40,000	50	0	2,757	MP
350	100,000	25	0	844	SP
353	200,000	5	0	82,370	MP
355	12,800	1	0	2,625	SP
356	75,000	5	5	70,400	MP
357	500,000	50	0	99,500	MP
358	53,326,000	50	1	2,757	MP
359	31,000	5	0	5,090	MP
360	20,000	25	0	77	MP
362	50,000	50	0	20,705	MP
363	16,000	25	0	77	MP
365	230,000	50	0	123,515	SP
367	21,483	5	50	5,090	SP
369	100,000	100	0	1,086	SP
370	15,000	5	0	77	SP
372	14,300	100	0	2,625	SP
373	89,760	25	0	82,370	MP

ID	Metal Finishing Waterflow	Annual Sales (Millions)	% Metal Finishing Customers	Annual Compliance Costs	Facility*
375	350,000	50	7	123,515	SP
378	22,000	5	10	5,090	SP
379	125,000	100	20	24,841	SP
381	86,000	50	15	7,380	SP
382	150,000	50	0	82,370	MP
383	1,500,000	100	5	342,604	SP
384	163,176	50	0	24,841	SP
385	14,000	50	1	2,625	MP
386	190,000	50	93	1,086	MP
387	32,000	50	0	70,400	SP
388	89,760	5	0	844	SP
389	160,000	1	80	24,841	MP
390	400,000	50	1	154,580	MP
391	37,400	5	0	2,757	SP
392	26,000	25	0	70,400	SP
393	45,000	50	0	31,430	MP
394	100,000	100	0	844	SP
395	180,000	50	0	1,086	MP
397	30,000	50	0	41,330	SP
398	35,000	100	0	18,025	SP
399	15,000	25	1	5,090	MP
402	185,000	50	0	844	MP
403	900,000	100	5	342,604	SP
404	175,000	100	1	56,479	SP
405	230,000	50	0	24,841	SP
406	93,000	25	5	844	MP
407	30,000	50	0	18,025	SP
410	13,200	5	0	77	SP
411	50,000	50	1	20,705	MP
412	290,000	50	1	99,500	MP
414	50,000	50	3	18,025	SP
415	12,000	50	1	2,625	MP
416	20,000	5	0	5,090	MP
418	115,000	50	3	24,841	MP
419	80,000	100	0	1,086	SP
420	15,250	50	85	77	MP
421	95,000	50	0	844	MP

ID	Metal Finishing Waterflow	Annual Sales (Millions)	% Metal Finishing Customers	Annual Compliance Costs	Facility*
422	250,000	25	0	123,515	MP
424	210,000	25	0	154,580	SP
425	50,000	50	0	20,705	MP
426	40,000	50	25	31,430	MP
427	60,000	50	0	41,330	MP
428	200,000	50	1	1,086	MP
429	148,000	50	0	844	MP
430	111,500	50	95	82,370	SP
431	172,300	1	80	844	SP
432	110,906	100	0	24,841	SP
433	80,000	5	0	31,430	MP
434	1,060,000	50	0	301,529	MP
435	65,000	5	0	31,430	SP
436	75,000	25	0	1,086	MP
437	192,000	50	0	24,841	MP
438	35,000	5	0	31,430	SP
439	21,424	25	30	77	MP
440	25,000	50	5	2,625	MP
441	155,910	5	0	56,479	SP
443	250,000	50	0	181,872	MP
444	56,000	5	25	7,380	MP
445	14,820	5	0	5,090	MP
446	136,884	50	0	844	MP
447	20,000	100	20	2,625	SP
449	32,000	50	0	31,430	SP
451	25,600	1	15	2,757	MP
452	348,000	100	0	154,580	SP
454	80,000	25	39	82,370	SP
455	44,000	25	0	52,600	MP
457	100,000	25	0	1,086	MP
458	57,000	25	0	2,757	MP
459	170,000	50	0	56,479	SP
461	122,000	50	0	1,086	MP
462	40,000	25	0	70,400	SP
463	90,000	25	0	844	MP
465	160,000	25	0	24,841	MP
466	26,500	5	6	31,430	MP

ID	Metal Finishing Waterflow	Annual Sales (Millions)	% Metal Finishing Customers	Annual Compliance Costs	Facility*
467	80,000	5	0	56,479	MP
469	167,000	50	2	28,370	MP
470	12,500	50	0	2,625	MP
471	45,000	50	0	70,400	MP
472	30,000	50	0	21,430	MP
473	115,000	50	0	56,479	MP
474	100,000	100	1	844	SP
475	748,000	25	0	337,305	SP
476	40,000	50	0	31,430	MP
477	14,000	50	50	5,090	MP
478	145,000	100	0	844	SP
481	4,000,000	50	20	344,604	MP
482	316,800	100	10	77,267	SP
483	250,000	50	5	1,175	MP
484	20,000	25	0	2,625	MP
486	500,000	100	0	77,267	SP
487	39,000	100	0	41,330	SP
488	145,000	100	50	56,479	SP
489	60,000	5	20	7,380	MP
490	39,000	50	0	20,705	SP
491	60,000	50	0	52,600	MP
492	45,000	50	0	7,380	SP
493	19,200	25	15	5,090	MP
494	169,416	50	0	844	MP
495	168,900	50	10	844	MP
497	16,800	100	50	77	SP
498	20,000,000	100	1	342,604	SP
499	35,000	50	2	18,025	SP
500	29,613	50	0	31,430	MP
502	1,700,000	100	0	342,604	SP
503	45,000	5	8	18,025	MP
504	30,000	100	0	2,757	SP
505	320,000	100	10	99,500	SP
507	18,000	50	0	77	MP
508	130,000	25	0	56,479	MP
509	15,000	1	5	2,625	MP
510	380,000	25	0	154,580	MP

ID	Metal Finishing Waterflow	Annual Sales (Millions)	% Metal Finishing Customers	Annual Compliance Costs	Facility*
511	90,191	100	20	1,086	SP
512	12,000	50	0	2,625	MP
513	50,000	50	0	52,600	MP
514	41,600	50	2	70,400	MP
516	13,000	25	0	2,625	MP
517	20,000	100	0	5,090	SP
518	50,000	100	0	18,025	SP
519	12,000	50	0	77	MP
520	325,000	100	5	181,872	SP
521	90,000	25	1	24,841	SP
522	310,040	50	0	154,580	MP
523	39,200	50	0	70,400	MP
524	45,000,000	25	0	337,305	MP
525	300,000	50	5	181,872	MP
526	40,000	50	0	70,400	MP
527	210,000	100	0	155,724	SP
529	158,000	100	5	82,370	SP
533	51,483	50	0	41,330	MP
534	400,000	50	1	155,724	MP
536	24,000	25	44	5,090	MP
537	200,000	50	0	82,370	MP
539	200,000	100	0	77,267	SP
540	158,000	100	0	844	SP
542	47,348	50	0	2,757	MP
543	150,000	50	10	844	MP
544	80,000	25	2	82,370	SP
545	13,000	25	0	77	MP
548	100,000	5	0	1,086	SP
549	40,000	50	0	70,400	MP
550	45,000	25	10	52,600	MP
552	35,000	50	5	18,025	SP
553	35,285	50	5	31,430	MP
555	700,000	100	8	301,529	SP
556	50,000	5	75	20,705	MP
557	600,000	100	8	342,604	SP
559	12,342,000	25	1	181,872	MP
560	14,960	50	5	2,625	MP

ID	Metal Finishing Waterflow	Annual Sales (Millions)	% Metal Finishing Customers	Annual Compliance Costs	Facility*
562	61,029	5	5	7,380	MP
563	24,884	25	0	77	MP
564	70,000	25	0	2,757	MP
565	225,000	50	0	77,267	SP
566	45,000	50	0	41,330	SP
567	110,000	50	0	844	MP
568	145,000	25	19	1,086	SP
569	130,000	25	0	56,479	MP
570	35,000	1	0	18,025	SP
571	25,000	100	0	52,600	SP
572	56,000	5	0	7,380	SP
573	150,000	50	9	24,841	SP
574	245,000	50	0	181,872	MP
576	172,800	100	0	56,479	SP
577	105,000	50	10	1,086	MP
578	844,000	5	80	301,529	MP
579	150,000	50	0	24,841	SP
580	65,000	100	2	20,705	SP
581	400,000	100	2	123,515	SP
582	90,000	50	0	82,370	SP
583	200,000	50	0	844	MP
584	50,000	100	0	31,430	SP
585	199,948	50	3	1,086	MP
587	23,000	50	0	5,090	MP
588	35,000	50	0	18,025	MP
589	125,000	50	0	1,086	MP
591	85,000	25	0	1,086	MP
593	90,000	50	0	56,479	MP
594	190,000	25	0	82,370	MP
595	560,000	100	1	301,529	MP
596	30,000	50	40	18,025	SP
598	38,500	50	5	52,600	MP
600	140,000	50	0	82,370	SP
602	120,000	50	10	844	SP
603	450,000	100	0	77,267	SP
604	141,000	100	0	1,086	SP
605	160,000	100	0	24,841	SP

ID	Metal Finishing Waterflow	Annual Sales (Millions)	% Metal Finishing Customers	Annual Compliance Costs	Facility*
607	130,000	100	50	56,479	SP
608	31,500	5	5	7,380	SP
610	100,000	25	0	56,479	MP
611	75,000	50	0	82,370	MP
612	33,000	50	0	31,430	SP
613	74,980	100	0	41,330	SP
615	20,000	100	5	18,025	SP
616	400,000	50	20	1,175	MP
617	500,000	50	0	155,724	MP
619	25,000	50	0	77	MP
620	25,000	50	0	5,090	MP
621	240,000	50	10	181,872	MP
622	56,615	50	0	70,400	MP
623	315,000	50	0	181,872	MP
624	600,000	100	0	342,604	SP
625	35,000	25	0	20,705	MP
626	131,398	50	15	24,841	MP
628	57,692	100	0	31,430	SP
629	500,000	100	0	77,267	SP
630	72,000	50	8	70,400	MP
631	22,158,752	50	0	337,305	MP
633	60,000	25	10	7,380	MP
637	50,000	50	0	18,025	MP
638	100,000	100	10	1,086	SP
640	40,000	50	0	31,430	MP
641	13,680	100	0	2,625	SP
644	57,000	50	0	18,025	MP
645	45,000	100	2	7,380	SP
646	64,000	50	0	41,330	MP
652	35,000	50	0	52,600	MP
654	181,255	50	1	82,370	MP
655	1,000,000	100	2	342,604	SP
657	387,000	50	0	181,872	MP
658	20,000	100	0	2,625	SP
659	125,000	50	0	24,841	MP
660	54,609	50	0	7,380	MP
661	17,170	25	35	77	MP

ID	Metal Finishing Waterflow	Annual Sales (Millions)	% Metal Finishing Customers	Annual Compliance Costs	Facility*
663	18,000	5	0	2,625	SP
664	10,429	50	0	2,625	MP
666	103,500	50	0	24,841	MP
667	12,000	1	0	5,090	MP
668	18,000	100	0	2,625	SP
669	79,000	100	1	82,370	SP
670	98,000	50	0	56,479	MP
671	638,900	100	0	301,529	SP
672	55,000	100	0	7,380	SP
675	600,000	100	0	301,529	SP
677	467,000	50	0	1,175	MP
679	42,000	50	0	20,705	MP
680	22,000	50	5	2,625	MP
681	200,000	50	60	844	MP
682	132,721	50	5	1,086	MP
683	151,000	100	2	24,841	SP
684	24,884	25	1	5,090	MP
685	150,000	100	0	24,841	MP
686	20,000	50	30	5,090	MP
687	162,135	100	0	24,841	MP
688	200,000	100	100	844	MP
690	95,000	100	5	7,380	MP
691	375,000	50	0	1,175	SP
693	200,000	100	20	844	MP
695	210,000	25	0	123,515	MP
696	130,000	25	0	844	SP

EXHIBIT C-9

ANNUAL SALES, WATER FLOW AND ANNUAL COMPLIANCE COSTS FOR INDIRECT DISCHARGING CAPTIVE MODEL PLANTS USING LESS THAN 10,000 G.P.D.

ID Number	MF Waterflow	Annual Sales (millions)	Annual Compliance Costs ($1982)	MF Customers %	Facility*
700	200	50	12,633	5	SP
703	175	100	12,633	0	MP
705	500	50	12,633	0	MP
707	3,468	50	12,633	0	SP
715	1,500	50	12,633	2	SP
729	200	1	12,633	0	SP
743	1,496	5	12,633	0	SP
744	900	1	12,633	5	SP
754	7,500	50	12,633	5	MP
755	400	1	12,633	0	SP
762	748	5	12,633	10	MP
764	8,787	1	12,633	30	SP
765	8,000	100	12,633	0	SP
768	6,000	100	12,633	0	SP
771	1,000	50	12,633	0	MP
776	5,000	5	12,633	0	MP
777	1,000	5	12,633	0	MP
778	50	50	12,633	0	MP
780	1,200	25	12,633	5	MP
789	1,000	50	12,633	0	MP
795	3,500	50	12,633	0	MP
796	6,000	50	12,633	0	SP
802	2,000	5	12,633	0	MP
803	1,000	50	12,633	0	MP

* SP denotes a single plant firm, MP denotes a multi-plant firm.

ID Number	MF Waterflow	Annual Sales (millions)	Annual Compliance Costs ($1982)	MF Customers %	Facility*
807	900	1	12,633	0	SP
812	75	1	12,633	0	SP
828	500	5	12,633	0	MP
829	6,250	50	12,633	0	MP
838	900	25	12,633	0	SP
841	20	5	12,633	0	SP
843	2	1	12,633	33	MP
856	300	50	12,633	0	MP
866	20	1	12,633	0	MP
872	3,000	5	12,633	0	SP
873	200	5	12,633	0	MP
874	5,000	100	12,633	0	SP
882	500	1	12,633	0	MP
895	500	5	12,633	0	MP
912	700	1	12,633	0	MP
922	750	50	12,633	0	MP
925	5,000	5	12,633	0	SP
939	450	5	12,633	0	MP
950	5	1	12,633	0	SP
953	1,000	50	12,633	0	MP
962	3,000	50	12,633	0	MP
984	1,400	5	12,633	0	SP
990	5,000	50	12,633	25	SP
991	4,000	1	12,633	0	MP
997	50	5	12,633	0	MP
1013	3,500	5	12,633	0	SP
1015	9,350	5	12,633	1	SP
1017	400	5	12,633	0	SP

* SP denotes a single plant firm, MP denotes a multi-plant firm.

ID Number	MF Waterflow	Annual Sales (millions)	Annual Compliance Costs ($1982)	MF Customers %	Facility*
1019	8,000	25	12,633	0	SP
1020	1,000	5	12,633	8	MP
1022	450	50	12,633	0	MP
1023	700	50	12,633	1	SP
1026	300	1	12,633	5	SP
1030	450	1	12,633	0	SP
1034	10	50	12,633	5	MP
1039	100	5	12,633	0	SP
1045	1,000	50	12,633	25	MP
1047	4,150	25	12,633	0	MP
1054	800	5	12,633	20	MP
1055	5,000	5	12,633	50	MP
1063	7,000	50	12,633	0	MP
1065	450	5	12,633	0	MP
1069	6,200	100	12,633	10	SP
1071	1,752	5	12,633	0	MP
1074	8,000	50	12,633	0	MP
1083	7,500	5	12,633	0	SP
1097	214	50	12,633	0	MP
1099	3,000	50	12,633	0	MP
1102	1,700	5	12,633	0	SP
1112	300	5	12,633	0	MP
1123	2,000	5	12,633	0	SP
1131	4,800	25	12,633	0	SP
1133	4,200	25	12,633	0	SP
1135	46	25	12,633	10	SP
1140	55	1	12,633	20	MP
1143	2,500	5	12,633	0	SP
1150	5,000	50	12,633	25	MP
1151	6,500	50	12,633	0	MP

* SP denotes a single plant firm, MP denotes a multi-plant firm.

ID Number	MF Waterflow	Annual Sales (millions)	Annual Compliance Costs ($1982)	MF Customers %	Facility*
1158	5,200	5	12,633	0	MP
1165	300	5	12,633	0	SP
1171	1,500	5	12,633	0	MP
1183	4,000	5	12,633	1	SP
1186	5,000	50	12,633	0	MP
1200	2,500	25	12,633	0	SP
1201	50	50	12,633	0	MP
1204	50	5	12,633	25	SP
1205	5,000	25	12,633	0	MP
1209	3,000	50	12,633	2	MP
1215	10	50	12,633	0	MP
1225	9,500	50	12,633	20	MP
1231	2,000	5	12,633	0	MP
1240	2,500	5	12,633	10	MP
1242	7,000	5	12,633	0	SP
1248	5,000	25	12,633	0	MP
1252	192	100	12,633	20	SP
1255	150	50	12,633	20	SP
1268	250	50	12,633	20	MP
1277	7,480	50	12,633	0	MP
1281	2,000	25	12,633	10	MP
1287	1,500	100	12,633	5	SP
1289	7,800	100	12,633	10	SP
1309	2,000	50	12,633	0	MP
1311	100	1	12,633	0	SP
1312	4,000	50	12,633	0	MP
1318	660	25	12,633	25	SP
1324	5,500	5	12,633	0	MP
1351	150	1	12,633	0	MP
1352	1,000	50	12,633	0	SP

* SP denotes a single plant firm, MP denotes a multi-plant firm.

ID Number	MF Waterflow	Annual Sales (millions)	Annual Compliance Costs ($1982)	MF Customers %	Facility*
1383	581	25	12,633	0	MP
1386	6,000	50	12,633	0	MP
1400	3,000	5	12,633	1	MP
1402	1,500	100	12,633	1	SP
1406	2,000	25	12,633	0	MP
1407	200	50	12,633	0	SP
1408	25	50	12,633	0	SP
1419	500	1	12,633	0	SP
1428	5,600	100	12,633	0	SP
1435	5,000	50	12,633	0	MP
1440	650	5	12,633	1	MP
1442	1,400	5	12,633	0	MP
1457	7,650	5	12,633	0	SP
1458	6,725	50	12,633	0	SP
1459	700	1	12,633	0	SP
1461	750	1	12,633	0	SP
1468	30	5	12,633	0	SP
1472	4,000	5	12,633	0	MP
1489	7,130	50	12,633	0	SP
1493	700	1	12,633	0	MP
1498	3,029	5	12,633	0	SP
1507	3,000	5	12,633	0	SP
1508	3,000	25	12,633	0	MP
1515	9,000	100	12,633	2	SP
1516	2,800	1	12,633	15	MP
1519	220	50	12,633	0	MP
1520	750	5	12,633	0	MP
1528	4,950	5	12,633	0	SP
1530	6,000	50	12,633	0	MP

* SP denotes a single plant firm, MP denotes a multi-plant firm.

ID Number	MF Waterflow	Annual Sales (millions)	Annual Compliance Costs ($1982)	MF Customers %	Facility*
1535	500	50	12,633	0	MP
1546	8,000	25	12,633	1	MP
1551	300	5	12,633	0	MP
1555	10	1	12,633	0	SP
1556	10	1	12,633	0	SP
1560	4,500	5	12,633	0	MP
1561	200	50	12,633	0	SP
1564	467	50	12,633	0	MP
1565	4,000	5	12,633	0	MP
1577	5,000	25	12,633	0	MP
1579	2,190	50	12,633	0	MP
1590	5,000	50	12,633	0	MP
1600	1,200	50	12,633	1	SP
1610	9,724	50	12,633	0	MP
1613	1,496	1	12,633	0	SP
1614	1,500	50	12,633	0	MP

* SP denotes a single plant firm, MP denotes a multi-plant firm.

EXHIBIT C-10

Option II Plant Cost Groupings For Indirect Discharging Captives*

Plant G.P.D. Category	Investment Cost	Annual Cost
0 - 10,000	10,340	3,412
10,001 - 25,000	24,500	8,085
25,001 - 75,000	49,100	16,203
75,001 - 200,000	80,200	26,466
200,001 - 500,000	135,000	44,550
Greater than 500,000	240,000	79,200

* These costs represent the marginal cost of achieving Option II compliance from Option I baseline. These costs were derived from costs generated by the technical contractor on 100 model plants. The cost associated with each waterflow group represents the average cost of plants that fall within that category.

APPENDIX D

EFFECT OF THE BUSINESS CYCLE ON PROJECTED METAL FINISHING IMPACTS

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EFFECT OF THE BUSINESS CYCLE ON PROJECTED METAL FINISHING IMPACTS

Most of the economic data on which this study is based was gathered in the year 1976. Since the proposed regulation will not take efffect until 1986, we have examined how the metal finishing universe has performed relative to the economy.

The vast majority of metal finishing is performed by captive plants who can be found in many four digit SIC industries, especially in 34 to 39. Since captives use finishing as an input to the production process of a wide variety of products, the durable goods sector of the economy was chosen as a proxy for metal finishing performance. Exhibits D-1 and D-2 display a comparison of real G.N.P. and the durable goods sector of the economy for the years 1976-1986. The exhibits show that no meaningful discrepancies exist, as the durable goods sector followed a pattern similar to the economy as a whole, no adjustments were made to the economic analysis.

EPA performed an additional analysis of the macroeconomic variables and forecasted the economic and financial performance of regulated industries over 1983-1990 as a function of the macroeconomic conditions. This analysis is presented in "Macroeconomic Conditions and Performance of Regulated Industries," JRB Associates, June, 1983.

There appears to be a strong correlation between macroeconomic conditions and the production and health of most industry sectors. Using both DRI and OMB forecasts, macroeconomic variables are projected to return to levels similar to the 1977-1979 period, the time period during which most data were collected.

EXHIBIT D-1

COMPARISON OF REAL GNP, INDUSTRIAL PRODUCTION AND DURABLE GOODS OUTPUT LEVELS FROM 1976 TO 1986

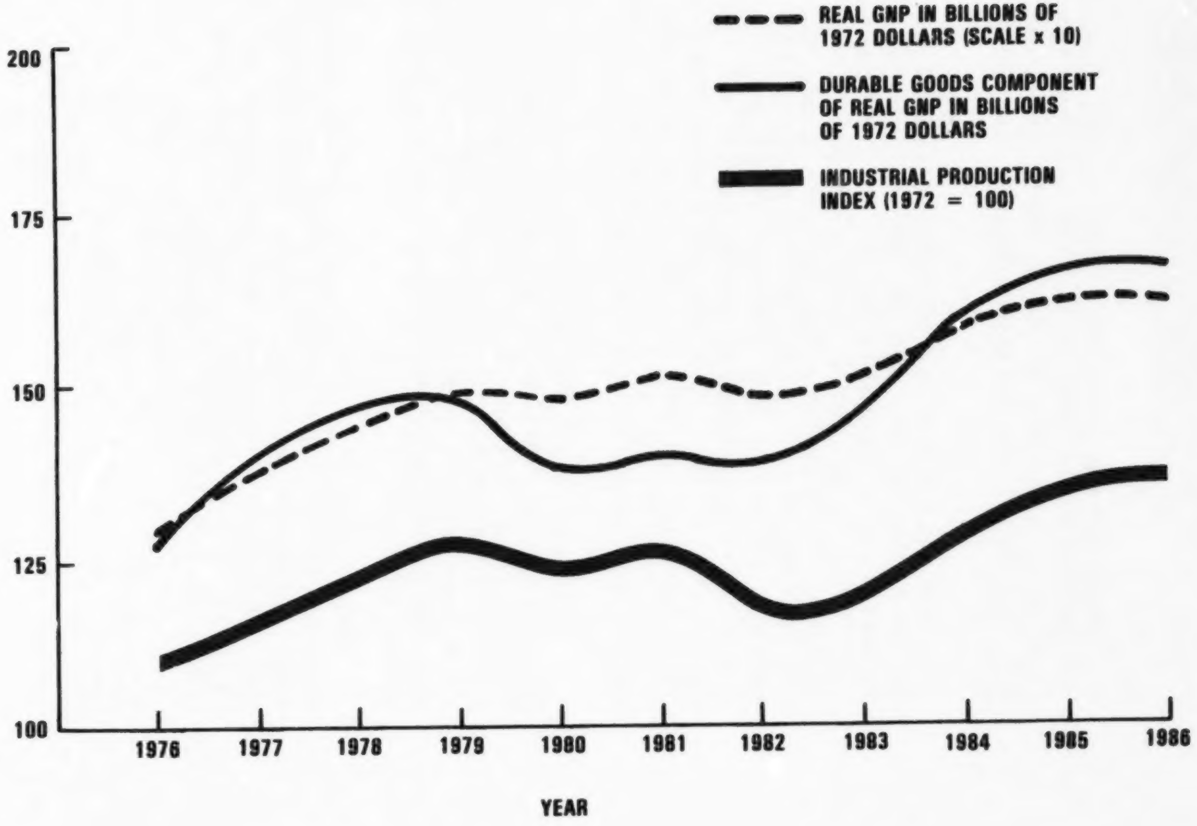

EXHIBIT D-2

Historical Data and Forecasts for Real GNP, Durable Goods Output and Industrial Production Levels Through 1986

YEAR	REAL GNP (BILLIONS OF 1972 $)[1]	DURABLE GOODS COMPONENT OF GNP (BILLIONS OF 1972 $)[1]	INDUSTRIAL PRODUCTION INDEX (1972 = 100)[2]
1976	1,298.2	126.5	109.0
1977	1,369.7	138.0	115.5
1978	1,438.5	146.8	122.0
1979	1,479.4	147.2	127.2
1980	1,474.0	137.1	122.8
1981	1,502.6	140.0	126.1
1982	1,476.7	137.8	116.2
1983	1,509.2	146.6	119.0
1984	1,575.6	160.5	128.5
1985	1,620.0	165.7	134.2
1986	1,671.3	171.4	138.7

1/ Based on historical data and forecasts contained in U.S. Long-Term Review; Winter 1982-83, Data Resources, Inc.

2/ Based on historical data from Business Statistics, U.S. Department of Commerce, Bureau of Economic Analysis, and forecasts contained in Industry Planning Service, Wharton Econometric Forecasting Associates, February 1983, Vol. 2, Number 2.

APPENDIX E

INPUT-OUTPUT ANALYSIS

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INPUT-OUTPUT ANALYSIS

This appendix first sets out a framework within which the interrelationships between consumption, production and metal finishing requirements can be measured. Then a method of quantifying the price relationships of the sectors in an economy, the input-output price model, is discussed.

All economic activities can be divided into two components, final demand and intermediate production. Final demand includes the personal consumption expenditures of consumers, the expenditures of business for capital goods replacement and/or augmentation, the expenditures of government at all levels, and the net exports. Intermediate production represents the inter-industry transactions necessary to produce the final goods and services. The inter-industry model, termed "input-output analysis", developed by Wassily Leontief [1] and recently estimated for the year 1972 by the Department of Commerce, provides the required framework [2] for estimating and analyzing the above mentioned interrelationships.

The basic input-output structure is developed by dividing the productive and final demand activities of an economy into a number of sectors, which are arrayed in matrix form. The distribution of the sales and purchases of each industry is then estimated for each sector during a 1-year period. As an example, Table E-1, panel (a), shows all economic activities divided into three producing sectors and one component of final demand. Reading across the rows, one finds the sales (in dollars) of the output of the sector named at the beginning of the row to the sector named at the head of each column. Or, reading down the column, one finds the purchases by each sector named at the head of the column from the sector named at the beginning of the row. Final demand can be further disaggregated into the components used in the national income accounts. Thus, the total final demand for the output of an industry is the sum of those components:

$$Y = C + I + G + T, \qquad (1)$$

Table E-1. Example of Input-Output Tables

(a) Transactions table, X matrix (Dollars)

Producing sectors	Consuming sectors agriculture	manufacturers	services	Total inter mediate output	Total final demand	Gross Output
Agriculture	40	80	0	120	80	200
Manufacturing	40	40	20	100	300	400
Services	0	60	20	80	120	200
Total inter-mediate inputs	80	180	40			
Value added	120	220	160		500	
Gross inputs	200	400	200			

(b) Direct requirements table, A matrix (Dollars/Dollars)

Producing sectors	Consuming sectors agriculture	manufacturers	services
Agriculture	0.20	0.20	0
Manufacturing	0.20	0.10	0.10
Services	0	0.15	0.10
Value added	0.60	0.55	0.60
Total	1.00	1.00	1.00

(c) Total requirements (direct and indirect) table, S matrix (Dollars/Dollars)

Producing sectors	Consuming sectors agriculture	manufacturers	services
Agriculture	1.33	0.30	0.03
Manufacturing	0.30	1.20	0.13
Services	0.05	0.20	1.13

where*

$Y = [y_i]$ final demand for the output of industry i, where i = 1....n,

$C = [c_i]$ personal consumption expenditure component of final demand for industry i output,

$I = [i_i]$ private investment expenditure component of final demand for industry i output,

$G = [g_i]$ government expenditure component of final demand for industry i output, and

$T = [t_i]$ net export component (exports minus imports) of final demand for industry i output.

The gross output of an industry is the sum of its sales to other industries and to final demand:

$$Z = XL + Y, \qquad (2)$$

where

$Z = [z_i]$ gross output of industry i,

$X = [x_{ij}]$ sales of industry i to industry j, where j = 1....n, and

$L = n$ dimensional unit vector.

Analogously, the gross input of industry is the sum of its purchases from other industries and of value added:

$$Z = X'L + V, \qquad (3)$$

where

$V = [v_i]$ value added by industry i, and

$X^{i} = [Xji]$ purchases of industry from other industries.

---

* Square-bracketed, lower-or upper-case subscripted variables denote vectors or matrices.

Gross national product is measured as the sum of final demand (expenditure approach) or the sum of value added (income approach).

Up to this point, the input-output table is essentially a system of accounting identities. However, in situations where producers are regarded as having only a limited choice regarding factor (i.e., input) intensities and where adjustments to shifts in demand take the form of quantity (i.e., output) rather than price adjustments, the transactions table can be utilized to develop a general set of production coefficients. Specifically, a set of technical coefficients can be derived from the transactions table. A technical coefficient is defined as the dollar input purchases from industry i per dollar output from industry j, or

$$A = [a_{ij}], \qquad (4)$$

where

$a_{ij} = x_{ij}/zj.$

Thus, continuing with our example in Table E-1, panel (b), the values in each column represent the composition of input to the industry named at the head of the column. To produce $1.00 of output, the manufacturing sector requires $0.20 of inputs from agriculture, $0.10 from manufacturing, $0.15 from services, and $0.55 of valued added.

Substituting the value of x_{ij} from equation (4) into equation (2) yields the result

$$Z= AZ + Y. \qquad (5)$$

This is equivalent to

$$(I-A)Z = Y, \qquad (6)$$

where

I = the identity matrix.

From equation (6) one can find the "total requirements matrix," S

$$Z = SY, \qquad (7)$$

where

$S = [s_{ij}] = [I-A]^{-1}.$

Each s_{ij} represents the dollar output of industry is required both directly and indirectly per dollar of final demand from industry j.

In Table E-1, panel (c), the s_{ij} elements of the hypothetical economy are shown. Reading down the column, each entry represents the output of the industry named at the beginning of the row per dollar of final demand from the industry named at the head of the column. Thus, to deliver $1.00 of manufactures to final demand requires $0.30 of output by the agriculture sector, $1.20 by manufacturing (the $1.00 for final demand plus the additional manufacturing output required to produce the required output of all three sectors), and $0.20 of the output of the services sector.

The three basic input-output tables thus provide the framework for analyzing the interrelations in an economy. To summarize:

1. The transactions table, X matrix, shows the flows between sectors per unit of time;
2. The direct coefficients table, A matrix, indicates the direct output requirements of each sector to produce one dollar's worth of output by every other sector; and
3. The total requirements coefficients table, S matrix, indicates the total (direct and indirect) output of each sector required to deliver one dollar's worth of output of every other sector to final demand.

The Bureau of Economic Analysis (BEA), U.S. Department of Commerce has developed several input-output tables of the U.S. economy. The latest, a 478-producing-sectors table based on the structure of production for 1972, has been employed in this study [2].

2. PERSONAL CONSUMPTION EXPENDITURES INTERRELATIONSHIPS

One drawback of input-output tables in terms of the objective of this study is their lack of resolution in the final demand sectors. Specifically, personal consumption expenditures are usually represented by a single column vector. Because the purpose of the impact model is to identify interrelationships between personal consumption expenditure items and the requirements for materials produced by the affected sectors, such as metal finishing requirements, this vector must be disaggregated into a set of consumer expenditure items. Unpublished BEA data used in developing the 1972 input-output table were used to develop a "bridge" between the 478 producing sectors in the input-output table and 477 personal consumption expenditure items.

Assuming there are m consumer products, one can define aggregate expenditures on these products as

$E = [e_m]$ the total dollar expenditure on each consumer product at retail prices. (8)

The Personal Consumption Expenditure (PCE) bridge is the allocation of the PCE vector among the m consumer expenditure items:

$$C = UL, \tag{9}$$

where

$C = [c_i]$ the personal consumption expenditure component of final demand for industry i output,

$\bar{L} = [1_i]$ m dimensional unit vector, and

$U = [u_{im}]$ the dollar amount of final demand sales from sector i required for production or distribution of consumer product m.

Using the hypothetical economy above, suppose all final demand was for three consumption goods which could be disaggregated as shown in Table E-2, panel (a).

Table E-2. Example of Diagrregated Personal Consumption Expenditures Tables

(a) Industrial composition of personal consumption expenditures table, U matrix (Dollars)

Producing sectors	PCE item 1	PCE item 2	PCE item 3	Total final demand
Agriculture	0	80	0	80
Manufacturing	200	0	100	300
Services	80	20	20	120
TOTAL(E)	280	100	120	500

(b) Distribution of the industrial composition of personal consumption expenditures table, B matrix (Dollars/Dollars

Producing sectors	PCE item 1	PCE item 2	PCE item 3
Agriculture	0.00	0.80	0.00
Manufacturing	0.71	0.00	0.33
Services	0.29	0.20	0.17
	1.00	1.00	1.00

(c) Total requirements personal consumption expenditures table, K matrix (Dollars/

Producing sectors	PCE item 1	PCE item 2	PCE item 3
Agriculture	0.22	1.07	0.25
Manufacturing	0.89	0.27	1.02
Services	0.47	0.27	0.36

The bridge can be converted into a set of fixed coefficients in a manner similar to that employed in developing the direct coefficients:

$$B = b_{im} = \frac{U_{im},}{e_m} \qquad (10)$$

where

b_{im} = dollar of final demand sales from sector i directly required per dollar expenditure on consumer product.

The distribution of the industrial composition of each expenditure item in the hypothetical economy is shown Table A-2, panel (b).

Last, from equations (7) and (10) we can create a matrix of the total output of each sector required per dollar of PCE on each item:

$$K = SB. \qquad (11)$$

The final matrix, Table E-2, panel (c), shows the output (in dollars) required by each industry named at the beginning of the row to produce and deliver one dollar's worth of the personal consumption expenditure item named at the head of the column.

In this hypothetical economy, private investment, government expenditures, and net exports are zero. Therefore, from equation (1) it is apparent that aggregate PCE expenditures are assumed to equal aggregate income, i.e., $C = Y$. Therefore, equations (7), (9), and (10) can be combined to state the further requirement that total production in the hypothetical economy equals the sum of the output requirements of all PCE items; i.e.,

$$Z = SY = SU\bar{L} = SBE,$$

or

$$Z = KE. \qquad (12)$$

3. THE PRICE SYSTEM

Input-output analysis offers a method of quantifying the price relationships of the sectors in an economy. Since the cost of any sector's output is composed of the costs of the materials inputs purchased from other sectors and such items as wages, profits, taxes, and depreciation which are a part of value added, there are implied price relationships in an input-output table. By defining unit price equal to unit cost, the price relationships between the price of different goods can be expressed as:

$$\begin{array}{lllll} p_1 = a_{11}p_1 & + a_{21}p_2 & + \dots & a_{n1}p_n & + v_{111} \\ p_2 = a_{12}p_1 & + a_{22}p_2 & + \dots & a_{n2}p_n & + v_{2\ 2} \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ p_n = a_{1n}p_1 & + a_{2n}p_2 & + \dots & a_{nn}p_n & + v_{n\ n} \end{array} \qquad (13)$$

where

p_i = the price of good i,

a_{ij} = the technical coefficients,

v_i = the share of primary inputs, and

$_i$ = the price of primary inputs.

By using the equation system (7), the effects of a price change in one sector upon the relative prices of every other affected sector's output can be calculated assuming each industry passes on its increased costs plus the rise in costs of inputs purchased from other industries to final demand. For the exposition of the input-output price model, refer to References 4 and 5.

An example of the procedure for determining price impacts on the value of final demand is shown below for the three sector economy shown in Table E-1. It is assumed here that prices of all sectors and all primary inputs in the base periods are equal to unity for the sake of simplicity. Further, suppose the price level in manufacturing increases 10 percent due to the increased costs necessary to comply with the proposed standard. The problem is to determine the new level of prices for agriculture and services.

When we assume that the prices of primary inputs in other sectors (i.e., Φ_1 and Φ_3) are not permitted to change, the relationship (13) for the three sector economy can be easily solved as below by first transposing all the know elements in each of the three equations to the right hand side and the unknown variables (and their coefficients) to the left hand side. Given our assumption, the "unknowns" are p_1, p_3, and Φ_2, and all other elements are known or assumed known. Thus, equation (13) for a three sector economy, with our stated assumption, may be written as:

$$p_1 = a_{11}p_1 + a_{31}p_3 + (a_{21}p_2 + v_1\Phi_1)$$

$$v_2\Phi_2 = -a_{12}p_1 - a_{32}p_3 + (1 - a_{12})\ p_2$$

$$p_3 = a_{13}p_1 + a_{33}p_3 + (a_{23}p_2 + v_3\Phi_3)$$

and solved as follows:

$$\begin{bmatrix} p_1 \\ \Phi_2 \\ p_3 \end{bmatrix} = \begin{bmatrix} (1 - a_{11}) & 0 - a_{31} & \\ a_{12} & v_2\ a_{32} & \\ -a_{13} & 0 & (1 - {}_{33}) \end{bmatrix}^{-1} \text{X} \begin{bmatrix} a_{21}p_2 + v_1\Phi_1 \\ (1 - a_{12})\ p_2 \\ a_{23}p_2 + v_3\Phi_3 \end{bmatrix}$$

$$\begin{bmatrix} p_1 \\ \Phi_2 \\ p_3 \end{bmatrix} = \begin{bmatrix} 0.8 & 0 & 0 \\ 0.2 & .55 & .15 \\ 0 & 0 & .90 \end{bmatrix}^{-1} \text{x} \begin{bmatrix} .2(1.1) + .6(1.0) \\ .8(1.2) \\ .1(1.1) + .8(1.0) \end{bmatrix}$$

$$= \begin{bmatrix} 1.25 & 0 & 0 \\ -.455 & 1.818 & -.303 \\ 0 & 0 & 1.11 \end{bmatrix} \text{x} \begin{bmatrix} .82 \\ .88 \\ .91 \end{bmatrix} = \begin{bmatrix} 1.025 \\ .951 \\ 1.0.0 \end{bmatrix}$$

Thus

$p_1 = 1.025$

$p_3 = 1.011$, and

$p_2 = 1.10$ by assumption,

So the effect of a 10 percent price increase in manufacturing has been a 2.5 percent increase in agriculture prices and a 1 percent increase in the price of services.

Using the share of final demand accounted for by each sector, a cost of living index can be computed. To illustrate this idea, recall the total final demand column from Table E-2, panel (1), in which the sector components of personal consumption expenditures were as follows: agriculture, 80; manufacturing, 300; services, 120. Thus, total final demand, or personal consumption expenditures, is 500, so the relative share for each sector is, respectively,

$$\frac{80}{500}, \frac{300}{500} \text{ and } \frac{120}{500}.$$

The respective prices from the preceding example are $p_1 = 1.025$, $p_2 = 1.10$ and $p_3 = 1.01$, so a cost-of-living index, C , can be obtained as follows:

$$c = 1.025 \frac{80}{500} + 1.10 \frac{300}{500} + 1.01 \frac{120}{500}$$

or

$$c = 1.0664$$

Thus, the increase in the cost of living as a result of a 10 percent price increase in manufacturing, was 6.6 percent.

4. ESTIMATES OF PRICE IMPACTS OF EPA REGULATIONS

The new level of prices for the 477 PCE items due to the proposed EPA regulations are determined following the increases of the price level of the metal finishing universe (SIC's 34, 35, 36, 37, 38, 39). Exhibit E-3 indicates the estimated price increases for each 2-digit SIC. The price impact on the major components of total final demand in the economy is computed based on the price increase in the metal finishing universe.

EXHIBIT E-3

Estimated Price Increases For 2-Digit SIC's (In Percent)

SIC	Option I	Option II
34	0.3	0.9
35	0.3	0.9
36	0.1	0.3
37	0.1	0.2
38	0.1	0.2
39	0.1	0.3

EXHIBIT E-4

Estimated Total Price Impact of EPA BATEA Metal Finishing Regulations or Principle Final Demand Components

Final Demand Sectors	Percentage Price Increase	
	OPT I	OPT II
Personal Consumption Expenditures	0.01	0.02
Gross Private Fixed Capital Formation	0.005	0.01
Net Exports	0.01	0.02
Total Federal Government Purchases	0.007	0.01

REFERENCES

1. Leontief, Wassily, Input-Output Economics, Oxford University Press, New York, 1966.

2. U.S. Department of Commerce, Office of Business Economics, 1972 Input-Output Structure of the U.S. Economy.

3. Bingham, T. H. and B. S. Lee, "An Analysis of the Materials and Natural Resource Requirements and Residuals Generation of Personal Consumption Expenditure Items, "RTI Final Report No. 41U-967, Prepared for Resource Recovery Division, Office of Solid State Management Programs, EPA, Feb. 1976.

4. United Nations, Problems of Input-Output Tables and Analysis, New York, 1966.

APPENDIX F
SENSITIVITY ANALYSES

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SENSITIVITY ANALYSES

This Appendix presents the results of sensitivity analyses performed on alternative assumptions pertaining to the metal finishing regulation. Sensitivity analyses were performed on the following assumptions:

- Wastewater monitoring costs
- Total toxic organics costs
- Metals and cyanide technology control costs.

1. WASTEWATER MONITORING COSTS

End-of-pipe monitoring costs currently incurred by the regulated facilities are shown in Exhibit F-1. Municipalities and permit writers have discretion in specifying monitoring frequencies. The economic analysis relies on frequencies traditionally specified. If monitoring is required 10 days per month, these costs will change. Exhibit F-1 shows the change in monitoring costs associated with a monitoring frequency of 10 days per month.

The costs shown in Exhibit F-1 were estimated by the technical contractor for the various wastewater usage categories. Per plant waste water monitoring costs were then assigned to model plants in the economic data base by these water flow categories. The marginal costs of wastewater monitoring costs for the regulated facilities were estimated by extrapolating from the model plants. Total annual costs and impacts are shown in Exhibit F-2. No closures or divestitures are projected to result from the additional wastewater monitoring requirements. Thus the change would not alter the determination that these standards are economically achievable.

2. TOTAL TOXIC ORGANICS COSTS

Two sensitivity analyses were performed for TTO. The first assumed an increase in the quarterly monitoring requirement to monthly monitoring, and the second assumed an increase in the size of the affected universe.

2(a) TTO Monthly Monitoring

In this sensitivity analysis, it was assumed that plants are required to monitor for TTO on a monthly basis. This assumption is particularly conservative for job shops and other small plants that have traditionally had relatively infrequent monitoring periods. The number of plants that will be required to monitor remains unchanged in this sensitivity analysis. Exhibit F-3 shows the affected universe, costs, and impacts of this analysis. It is assumed that there will be no change in the baseline monitoring requirement but that the annual cost of compliance monitoring will increase from $2890 per plant to $8610 per plant. One indirect discharging job shop is projected to close as a result of additional costs.

2(b) Increase in the Size of the Universe Required to Monitor for TTO

It was assumed in this analysis that baseline monitoring requirement would remain unchanged, and that the number of facilities required to compliance monitor would double. Thus, for job shops 5.6 percent of the population will have to monitor rather than 2.8 percent. A total of 13 percent of captives will be required to monitor rather than 6.5 percent, and 54 percent of IPCBs will monitor instead of 27 percent. It was also assumed that 2.8 percent of the indirect discharging job shops using toxic organics will have to pay $3600 annually to dispose of the toxic organics. The 2.8 percent figure is the number of indirect discharging job shops which the Agency estimates currently dump their solvents. Thus, this sensitivity analysis also assumes that none of the indirect discharging job shops could profitably reclaim or recycle their solvents but instead assumes that all would have to pay to dispose of their solvents. This conservative assumption more than doubles the expected annual compliance costs for the affected universe, yet leads to no additional impacts. Exhibit F-4 shows the costs and impacts of this analysis. No closures or divestitures are projected to result from the additional costs. Thus the economic achievability of these regulations is not altered.

3. METALS AND CYANIDE TECHNOLOGY CONTROL COSTS

In this sensitivity analysis all costs associated with the control technology of metals and cyanide were increased by 30 percent. This analysis covered indirect discharging captives under Option 1. Each plant's compliance cost was increased by 30 percent and the impacts assessed. The methodology for this impact assessment is discussed in Chapter IV and Appendix B. The annual cost of compliance increased from $115.6 million to $150.2 million and the investment cost from $351.0 million to $456.3 million. No closures resulted from the 30 percent cost increase. Again, no reassessment of regulatory decisions is necessary.

Exhibit F-1
WASTEWATER SAMPLING FREQUENCY AND ASSOCIATED COSTS***

Wastewater Discharge GPD	Sampling Frequency Assumed in Regulation	Estimated* Current Monitoring Costs
0 - 10,000	12 per year	$1,200
10,000 - 50,000	24 per year	$2,400
50,000 - 100,000	52 per year	$5,200
100,000 - 250,000	104 per year	$10,400
250,000 +	156 per year	$15,600

For 10 samples per month:

Wastewater Discharge** GPD	Additional Sampling	Additional Cost*
0 - 10,000	108/yr	$10,800/yr
10,000 - 50,000	96/yr	$ 9,650/yr
50,000 - 100,000	68/yr	$ 6,800/yr
100,000 - 250,000	16/yr	$ 1,600/yr
250,000 +	-36/yr	($ 3,600/yr)

* Assumes $100 per sample 4/28/83 quote from Technical Contractor is $80 - $100 per sample).

** Total Metal Finishing Flow.

*** Source: Development document and technical contractor.

Exhibit F-2

MARGINAL COSTS AND IMPACTS FOR WASTEWATER MONITORING

	Job Shops Directs	Direct Captives	Indirect Captives	Direct IPCB
Number of Plants Affected	365	2500	7500	44
Annual Cost ($1982 millions)	3.5	11.5	45.5	0.5
Closures	0	0	0	0
Average Cost Increase (%)	0.9	0.05	0.05	0.3

Exhibit F-3
COSTS AND IMPACTS OF MONTHLY TTO MONITORING

	D.D. Job Shops	I.D. Job Shops	Direct Captives	Indirect Captives	D/I.D. IPBC
Affected Universe	10	76	162	487	100
Annual Costs	86,700	658,920	1,404,540	4,222,290	867,000
Closures	0	1	0	0	0
Closures as a Percent of Affected Plants	0	.037%	0	0	0

Exhibit F-4

COSTS AND IMPACTS OF TTO MONITORING WITH HIGHER PERCENTAGE OF PLANTS MONTIORING

	D.D. Job Shops	I.D. Job Shops*	Direct Captives	Indirect Captives	D/I.D. IPCB
Affected Universe	20	152	324	974	200
Annual Costs	75,800	712,880	936,360	2,814,860	578,000
Closures	0	0	0	0	0
Closures as a Percent of Affected Plants	0	0	0	0	0

* Includes solvent disposal costs of $3600 per year per plant -- applicable to 2.8 percent of the facilities.

APPENDIX G

TTO BASELINE MONITORING COSTS FOR PLANTS WITH WATER USAGE GREATER THAN 250,000 GPD

APPENDIX G

TTO BASELINE MONITORING COSTS FOR PLANTS WITH WATER USAGE GREATER THAN 250,000 GPD

The Agency assumed that all facilities using toxic organics will incur baseline monitoring costs (Chapter V of the report presents estimates of the universe that will be required to baseline monitor). All facilities using less than 250,000 GPD in their metal finishing operations are peojected to incur a one time cost of $1,904 for baseline monitoring. This cost projection is based on monitoring by taking three samples. Plants which use more than 250,000 GPD are projected to incur additional baseline monitoring costs of $1,904 since they are required to take six samples.* The total additional baseline monotoring costs for plants with metal finishing water use of greater than 250,000 GPD is estimated to be $1.3 million. This cost will be distributed equally among the 683 plants in the metal finishing universe that use total toxic organics and whose water use is greater than 250,000 GPD. Exhibit G-1 on the following page displays the additional TTO baseline monitoring costs and the number of affected plants in each segment of the metal finishing universe. The additional TTO costs for plants with water use greater than 250,000 GPD will not result in plant closures or divestitures.

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*Sampling requirements are outlined in 40 CFR 403.12B.